

PB-213 091

USER'S MANUAL FOR THE APRAC-1A URBAN
DIFFUSION MODEL COMPUTER PROGRAM

R. L. Mancuso, et al

Stanford Research Institute

Prepared for:

Coordinating Research Council
Environmental Protection Agency

September 1972

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PB 213 091

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By: R. L. MANCUSO and F. L. LUDWIG

Prepared for:

COORDINATING RESEARCH COUNCIL
30 ROCKEFELLER PLAZA
NEW YORK, NEW YORK 10020

ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF METEOROLOGY
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CONTRACT CAPA-3-68(1-69)

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BIBLIOGRAPHIC DATA SHEET		1. Report No. CRC-CAPA-3-4	2.	3. Recipient's Accession No. PB-213 041
4. Title and Subtitle User's Manual for the APRAC-1A Urban Diffusion Model Computer Program			5. Report Date September 1972	
7. Author(s) R.L. Mancuso and F.L. Ludwig			8. Performing Organization Rept. No. SRI 8563	
9. Performing Organization Name and Address Stanford Research Institute Menlo Park, California 94025			10. Project/Task/Work Unit No. CRC-APRAC-CAPA-3-68	
			11. Contract/Grant No.	
12. Sponsoring Organization Name and Address Coordinating Research Council, 30 Rockefeller Plaza, New York, N.Y. 10020 and Environmental Protection Agency, Division of Meteorology, Research Triangle Park, N.C. 27711			13. Type of Report & Period Covered	
			14.	
15. Supplementary Notes Releasable to the public November 1972				
16. Abstracts The APRAC-1A diffusion model was developed as a versatile and practical model for computing the concentrations of pollutants at any point within a city. The model calculates pollutant contributions from diffusion on various scales, including: extraurban diffusion, mainly from sources in upwind cities; intraurban diffusion from freeway, arterial, and feeder street sources; local diffusion of emissions within a street canyon. The model treats only carbon monoxide (c)), a relatively inert gas in the atmosphere but an important pollutant in terms of health. Motor vehicles are the major source of this gas.				
17. Key Words and Document Analysis. 17a. Descriptors Carbon Monoxide Intraurban Diffusion Extraurban Diffusion Atmosphere Air Pollution Vehicular Traffic Air Traffic				
17b. Identifiers/Open-Ended Terms San Jose, California St. Louis, Missouri Continuous Air Monitoring Program (CAMP)				
17c. COSATI Field/Group 09B; 04A I				
18. Availability Statement Releasable to the general public			19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 120
			20. Security Class (This Page) UNCLASSIFIED	22. Price



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SRI Project 8563

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LIST OF SYMBOLS

<u>Text Symbols</u>	<u>Program Symbols</u>	<u>Definition</u>
a, b	A, B	Parameters to define σ_z
α, β	PF1, P01	Vehicle emission constants
C	CCAL	CO concentration at receptor
C_b	CCAL	CO concentration computed by extraurban and intraurban models
C_e	EXTRAQ	CO concentration computed by extra- urban model
ΔC	--	CO concentration computed by street model
E	--	Vehicle emission rate
F	FUEL	Annual consumption of fuel within a 22.5-degrees angular sector from 32 to 1000 km upwind of receptor
H	Z3	Average building height
h	HT	Mixing depth
i	I	Upwind area segment index
j	IJ or JI	Stability class index
K, L_o	CK, XL0	Empirical constants
P_t	PT12, PT34, PT6, PTSAT, PTSUN	Hourly traffic factor
Q_A	--	Emission rate for area segment
S	S	Average vehicle speed on traffic link
σ_z	--	Vertical dispersion coefficient
U_a	WS	Airport wind speed
u	--	Transport or rooftop wind speed
W	WWST	Width of street
x	R or YR	Upwind distance from receptor

I INTRODUCTION

The APRAC-1A^{*} diffusion model has been developed as a versatile and practical model for computing the concentrations of pollutants at any point within a city. It is the result of the studies of Ludwig et al. (1970, 1972)[†] and Johnson et al. (1971) and includes the most recent modeling features of these studies. The model calculates pollutant contributions from diffusion on various scales, including:

- Extraurban diffusion, mainly from sources in upwind cities.
- Intraurban diffusion from freeway, arterial, and feeder street sources.
- Local diffusion of emissions within a street canyon.

Currently, the model treats only carbon monoxide (CO), a relatively inert gas in the atmosphere but an important pollutant in terms of health. Motor vehicles are the major source of this gas.

A brief summary of the APRAC-1A model development and evaluation program is given in Section II. The basic model formulation is briefly described in Section III. More detailed descriptions of both the theory and the numerical techniques are given in reports by Ludwig et al. (1970, 1972) and Johnson et al. (1971). These reports should be used to supplement the information in this manual.

* The acronym APRAC is derived from the initial letters of the Air Pollution Research Advisory Committee, under whose auspices this research has been conducted. The members of this committee are drawn from the Coordinating Research Council (CRC) and the Environmental Protection Agency (EPA). The designation 1A refers to the present version of the model; with future improvements the designation will be changed to APRAC-1B, APRAC-1C, and so on.

† References are listed at the end of the body of the report.

A detailed description of the APRAC-1A computer program and its use is given in Section IV. The computer program can be used to make calculations of the following types:

- Synoptic model: hourly concentrations as a function of time, for comparison and verification with observed concentrations and for operational applications.
- Climatological model: the frequency distribution of concentrations, for statistical prediction of the frequency of occurrence of specified high concentrations in connection with planning activities.
- Grid-point model: concentrations at various locations in a geographical grid, providing detailed horizontal concentration patterns for operational or planning purposes.

A complete listing of the program and listings of input and output data of an actual run are given in Appendices A, B, C, and D.

II SUMMARY OF MODEL DEVELOPMENT AND EVALUATION PROGRAM

The APRAC-1A urban diffusion model was developed to simulate CO concentrations from readily available meteorological and traffic data. The model is based on existing experimental data and previous research results. The CO concentrations calculated with the model were initially compared with measured data from Continuous Air Monitoring Program (CAMP) stations; the calculated and observed values often differed significantly in magnitude, although they had similar trends.

An extensive measurement program was undertaken in San Jose, California to determine the causes of the discrepancies between calculated and observed concentrations. The measurements showed that roof-level winds blowing across a street canyon cause a helical circulation in the canyon. The resulting street-level CO concentrations differed by as much as a factor of three from one side of the street to the other. One of the principal accomplishments of the research in San Jose was the development of a new submodel to describe these street-canyon effects. The submodel substantially improved the agreement between observations and calculations. The San Jose program also uncovered and corrected other shortcomings of the original model. The resulting changes resulted in more realistic specification of atmospheric stability and turbulent diffusion in urban areas.

San Jose is a moderate-sized city and the question arose whether the San Jose results would be generally applicable to larger cities with taller buildings. To answer this question another extensive measurement program was undertaken in St. Louis. One of the primary concerns of the St. Louis research was evaluation of the performance of the street-canyon

submodel in street canyons deeper than those studied in San Jose. To test the generality of the San Jose observations, two street canyons, with height-to-width ratios of about 1.5 and 2, were instrumented in St. Louis, so that CO concentrations could be measured on both sides of each street at five heights, from 4 m to roof level. Concentrations were also measured in midstreet at 7 m and 35 m (roof level). Winds in the street canyon were measured on either side, at 4.5 m and at roof level. Larger-scale airflow and CO concentrations in the area were monitored with instrumentation up to a height of 130 m on a television transmitting tower on top of a building at the intersection of the two streets. These data are available on magnetic tape from the National Climatic Center.*

The data collected show that a single-helix circulation is found in the deep street canyons of St. Louis and that the simple model developed from the San Jose data is fundamentally correct for the deeper canyons. Some slight modifications were required to account for the entrainment of recirculating polluted air in the downward-flowing part of the helical circulation. There had been evidence of this entrainment in the San Jose data also. The data indicate that the helical circulation develops when the roof-level winds are at an angle of more than 30 degrees to the street direction. When the winds are more nearly parallel to the street, cross-street gradients were found to be small. For winds parallel to the street, the street-canyon submodel describes the vertical gradients as an average of the two expressions used when the winds are blowing across the street. The small changes that were made in the street-canyon submodel have improved the model's ability to predict the CO gradients in street canyons. Observations made at street level with mobile equipment

* National Climatic Center
National Oceanic and Atmospheric Administration
Federal Building
Asheville, N.C., 28801.

indicate that the street-canyon submodel is applicable through most of the block, at least to within about 10 m of the intersection.

The submodel used to calculate atmospheric stability was revised to give results that are more consistent with the fluctuations of wind direction observed on the television tower. It was found that for a given stability type, there is appreciably greater fluctuation in wind direction when the air has an urban fetch than when it has a nonurban fetch. This fact lends support to the revisions made during an earlier phase of the program that effectively increased diffusion rates in the urban situation as compared to the rural.

Model calculations of mixing depth were compared with lidar (laser radar) observations of the aerosol layer, and with radiosonde measurements of the temperature profile near the downtown center. From these comparisons it was concluded that the mixing-depth submodel does as well as is now possible using routinely available data.

Helicopter and van measurement of CO concentrations around the downtown area were combined with wind speed measurements so that a mass budget analysis could be performed to estimate the rate of CO emissions by traffic in the study area. The emission submodel was applied to the same area, and the results were compared. Uncertainties in the wind field, possible changes in CO emission rates during the measurement periods, and uncertainties in traffic amounts all contribute to the difficulties in making reliable comparisons, but the results were adequate to show any serious deficiencies in the model. On the average, the three cases analyzed in St. Louis and the four earlier cases from San Jose show agreement within a factor of two. With the data currently available there does not seem to be sufficient justification for changing the emission submodel.

The revisions and additions that have been made in the model since it was originally formulated have substantially improved its performance. When the revised model was applied in St. Louis and compared with observed hour-average CO concentrations, the root-mean-square difference between the calculated and observed values ranged from 2.6 to 3.9 ppm, depending on the particular observation site. This is about half the uncertainty of the original model when it was applied to this same city. If the calculated and observed data are fit by linear regression, the corresponding differences are reduced to values between 1.6 and 3.3 ppm. Also, the correlation coefficients between calculated and observed CO have been improved substantially. They are now in the range 0.4 to 0.7, as opposed to the 0.2-to-0.4 range found before revision. The ability of the model to specify frequency distributions of concentration is good. Median and 90-percentile concentrations are specified within about 2 and 3 ppm of the observed values, respectively. Use of regression relationships derived from the observed concentrations and those calculated with the model reduces the error in specifying median and 90-percentile concentrations to about 1.3 ppm.

The APRAC-1A model is now sufficiently accurate that it can be used for planning purposes. Some improvements and extensions are still desirable, including better specification of emissions and a new submodel to describe the effects that take place in the immediate vicinity of a freeway.

III BASIC MODEL

A. Primary Traffic Data and CO Emission Rate

The APRAC-1A diffusion model is based primarily on the CO emissions from a network of traffic road segments or links. An example of the network of traffic links for Chicago is shown in Figure 1. Each of these links is assigned an average daily traffic volume (expressed in vehicles per day) based on historical, current, or forecast data obtained from appropriate traffic agencies. Each link is identified by the geographical locations of its end points and is designated as a particular road type, such as freeway arterial, or local street (see Table 1). To calculate the traffic volume for a given hour, an hourly factor (P_t), which is illustrated in Figure 2, is first applied to the daily traffic volumes. Values for this factor can also be obtained from traffic agencies. Then the CO emission rate, E (g-CO vehicle-mi⁻¹), is estimated from the mean vehicle speed, S (mi h⁻¹) by using an empirical equation of the form

$$E = \alpha S^{-\beta} \quad (1)$$

α and β are constants that depend on the characteristics of the emission control devices installed and the mixture of old and new model cars on the road. For current CO calculations α is taken to be 700 and β to be 0.75. These values are appropriate to a mixture of about half pre-1968 (1966 for California) and half newer cars (Johnson et al., 1971). For cars produced since 1968, the value of β has been 0.48. Existing and potential legislation requires α to decrease with time, as shown in Table 2. For future years, the effective values of α and β for use in Eq. (1) have to be determined on the basis of the fraction of the total

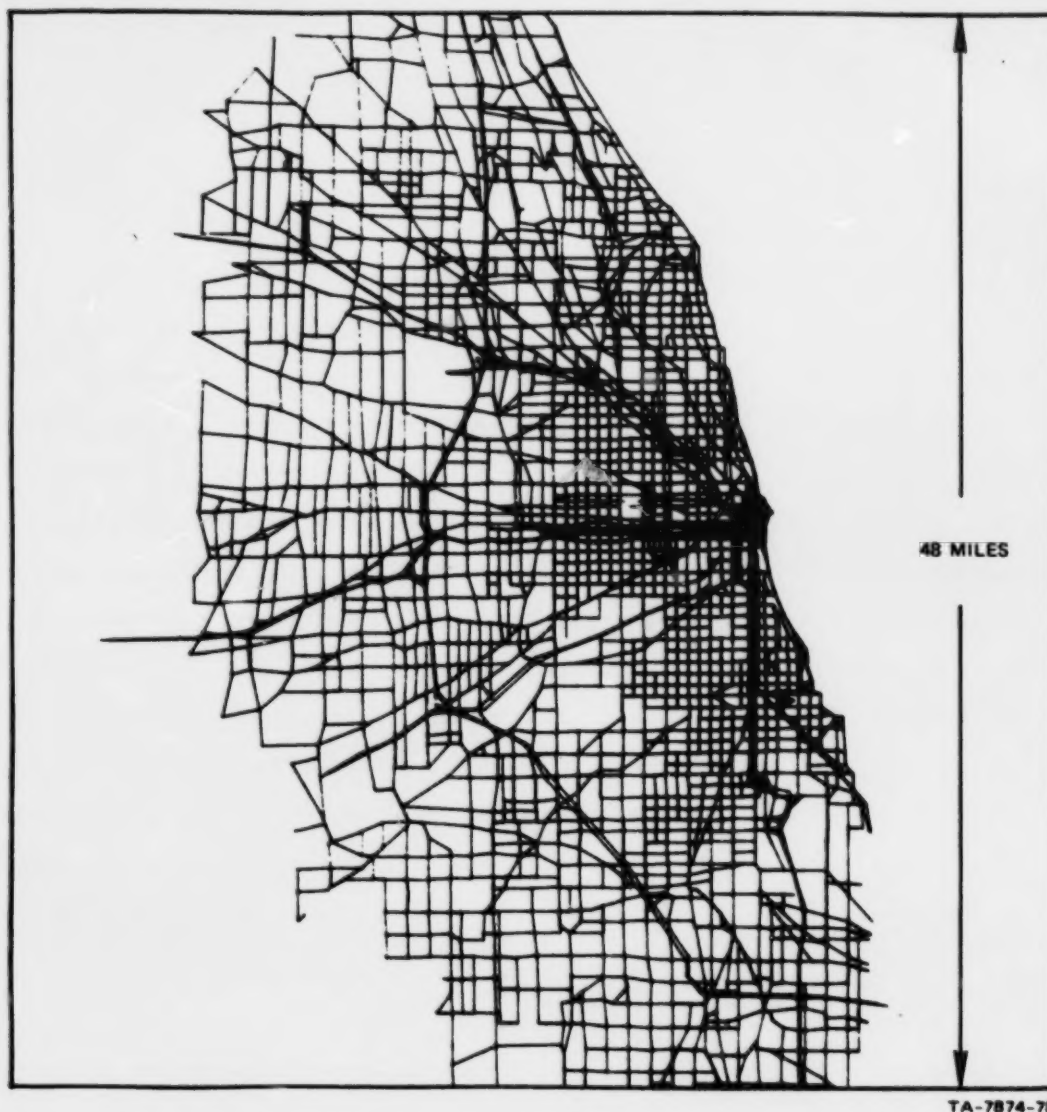


FIGURE 1 COMPUTER DISPLAY OF TRAFFIC LINKS FOR CHICAGO

cars represented by each model year. The model values of S are shown in Table 1. These values depend on the type of road and the time of day, that is, whether peak or off-peak traffic hours. The total CO emission from a given traffic link is found by multiplying E by the length of the link (mi) and by the hourly traffic volume.

Table 1

FACILITY CODES AND CAR SPEEDS FOR ST. LOUIS

Traffic Link Type	Code	Average Car Speed in Off-Peak Hours* (mi h ⁻¹)
Downtown		
freeway	1	43
arterial	2	9
Suburban		
freeway	3	53
arterial	4	20
Local	5	12
Street model	6	9
	7	5

* Peak-hour car speeds are set at 0.85 of off-peak-hour values.

Although it is possible to use emission data averaged over 1- or 2-mi grid squares, * this procedure is believed to be undesirable because of the loss of spatial resolution. Carbon monoxide concentrations are highly variable over short distances in the vicinity of roadways (Ott, 1972), and much of this variability is reflected in the calculated concentrations when the input data for individual links are used. However, sample calculations using smoothed emission fields indicate that by this means the variability is reduced to about half that obtained by using link input data (Coventry and Ruff, 1972).

* This modification of the model has in fact been made by D. Coventry and R. Ruff of the Environmental Protection Agency, Research Triangle Park, North Carolina.

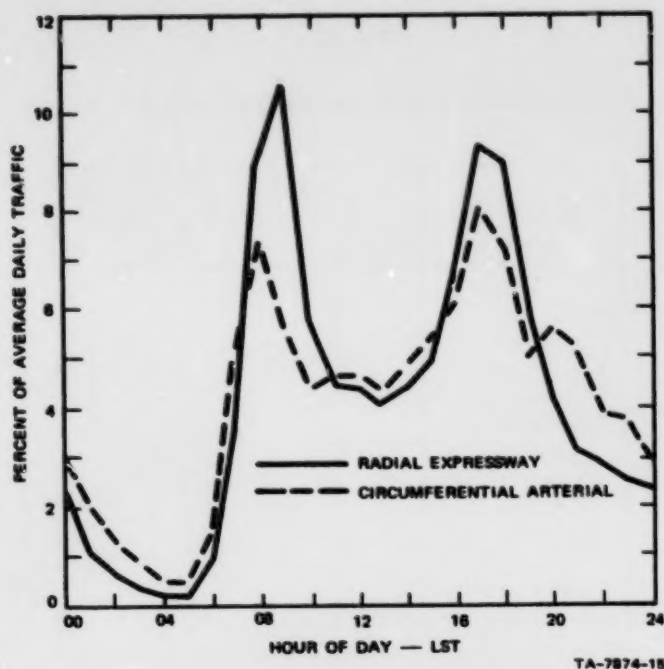


FIGURE 2 HOURLY DISTRIBUTION OF TRAFFIC FOR TWO FACILITY TYPES IN ST. LOUIS

Table 2

VALUES OF α FOR CARS PRODUCED AFTER 1970

Model Years	α
1972-1974	160
1975-1979	16
After 1980	8

A typical form in which traffic data are made available by traffic agencies is shown in Figure 3, a segment of the traffic map of the St. Louis area. As is often the case, the downtown traffic must be obtained from a separate, more detailed map of the same general form. Figure 3



NOTE: Figures represent estimated average annual two-way weekday traffic volumes.

SOURCE: Prepared by the Missouri State Highway Department Division of Planning in cooperation with the U.S. Department of Transportation Federal Highway Administration.

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FIGURE 3 PORTION OF A TYPICAL TRAFFIC MAP

also illustrates another common problem, that of different jurisdictions within the same metropolitan area. In this case, East St. Louis (Illinois) traffic must be obtained from another map, and that map may be of a different scale, requiring some coordinate transformation.

When traffic maps have been obtained from the appropriate agencies, the x and y coordinates must be measured for the end points of each of the links. These coordinates, the daily traffic volume, and the street type must be punched on cards. The street type should probably be assigned by a traffic engineer or someone of similar background. The rest of the operation can be accomplished by a data aide. Typically, it takes one to two weeks for a data aide to convert the data for an area like St. Louis from a form like that shown in Figure 3 to punchcards suitable for input to the model. The more maps of different scales that are required, the longer will be the time.

Not all the city's traffic is represented by the primary links shown in Figure 3. The number of vehicle-miles traveled on streets not represented by the primary network is computed from an estimate of the total vehicle-miles traveled in the area (based on such a measure as total fuel consumption) less the total vehicle-miles traveled on the links of the primary network. The number thus computed is distributed over the study area by estimating the relative density of local streets as opposed to parks, open spaces, or streets already coded, for each 4-mi² area of a 2-mi-by-2-mi grid covering the area. The emissions from the local street travel in a given square are assumed to emanate uniformly from that square. Although the emission per vehicle mile is high on the local streets because of low speeds, the overall contribution is small because of the small number of vehicles.

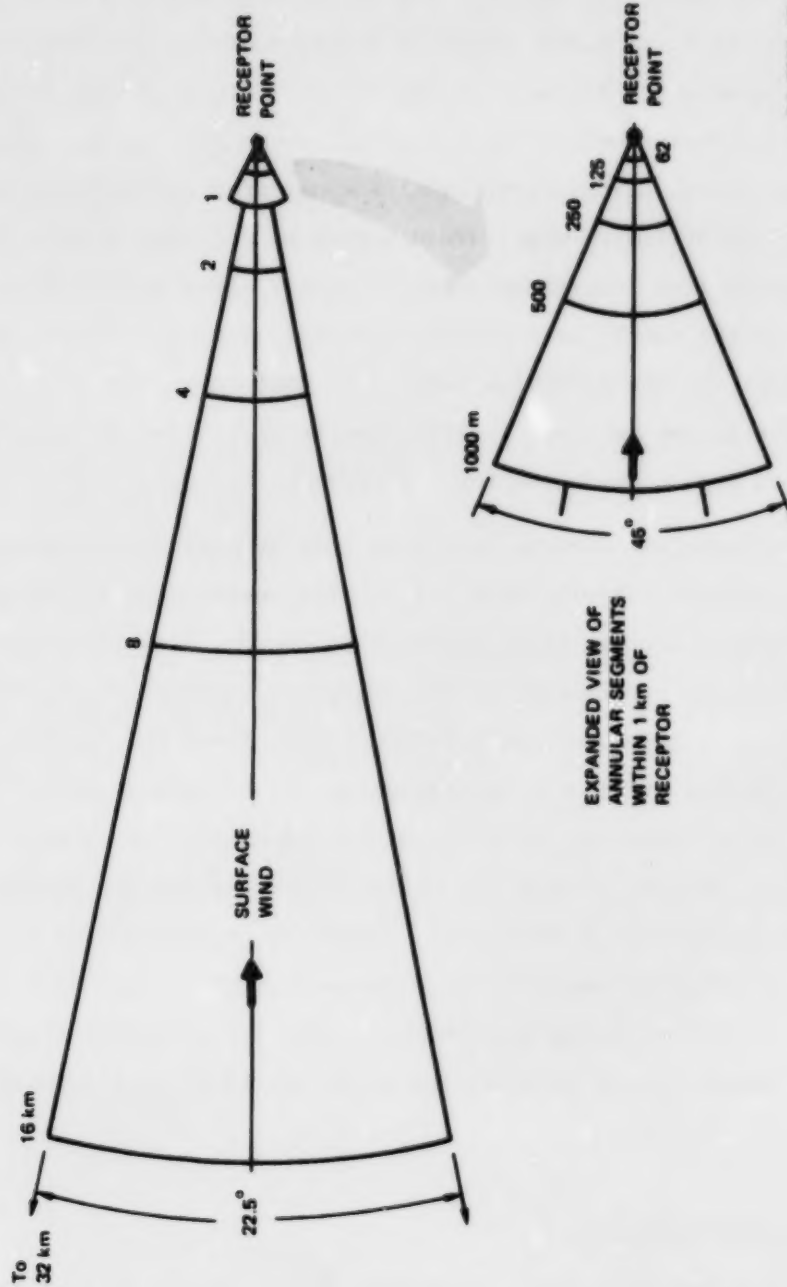
Most urban areas in the United States have completed an area-wide transportation study to determine traffic demands and transportation

facility needs for future years, for example, 1980 or 1990. Such a study is required for participation in a Federal Highway Administration program. An important result of such a study is a design of a future traffic network for an area and a forecast of the traffic volumes on the links of this network. The procedure for conducting these studies has been highly developed and partially standardized. The emission inventory components of the APRAC-1A diffusion model are designed so that the network description (including link length and facility types), link volume, and link speed data of the widely used traffic-planning computer programs can serve as input for the diffusion model. In most cases, the only manual step required to use forecast traffic conditions will be the measurement and coding of node coordinates for the network.

Traffic forecasts include travel on both primary and secondary networks. The primary network links are usually represented in the traffic forecast analysis much as they appear in Figure 3. However, local or feeder streets are represented in the analysis as connectors between the assumed center of population of a traffic zone, where all traffic in that zone is assumed to originate, and points on the primary network. The vehicle-miles on connector links therefore approximate those expected on local streets, but the traffic is concentrated on a few fictitious links, rather than spread over a broad area. This can be compensated for in the model by averaging the emissions from these fictitious secondary links over the 2-mi by 2-mi background grid, so that the connector links never explicitly appear in the calculations as do the individual primary network links.

B. Intraurban Diffusion

The intraurban diffusion calculation uses a number of area segments spaced at logarithmic upwind-range intervals from a receptor point, as shown in Figure 4. These area segments are oriented normal to the



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FIGURE 4 DIAGRAM OF SEGMENTS USED FOR SPATIAL PARTITIONING OF EMISSIONS

direction of the transport wind, and they overlay the traffic network. The traffic links and portions of links falling within each area segment are identified, and the emissions from the individual links are accumulated. Emissions are assumed to be released uniformly over the entire area of the segment. To save computer time, the emissions within the four segments farthest from the receptor are calculated by using a grid-point technique described by Ludwig et al. (1970). The CO contributions from each of the nine area sources are computed individually and then added to find the total intraurban concentration of CO at the receptor point.

A "Gaussian-plume" diffusion formulation is used for the calculations. The vertical concentration profile from a crosswind line source (such as a road) is assumed to be Gaussian in shape, as shown schematically in Figure 5. The spread of this vertical concentration distribution

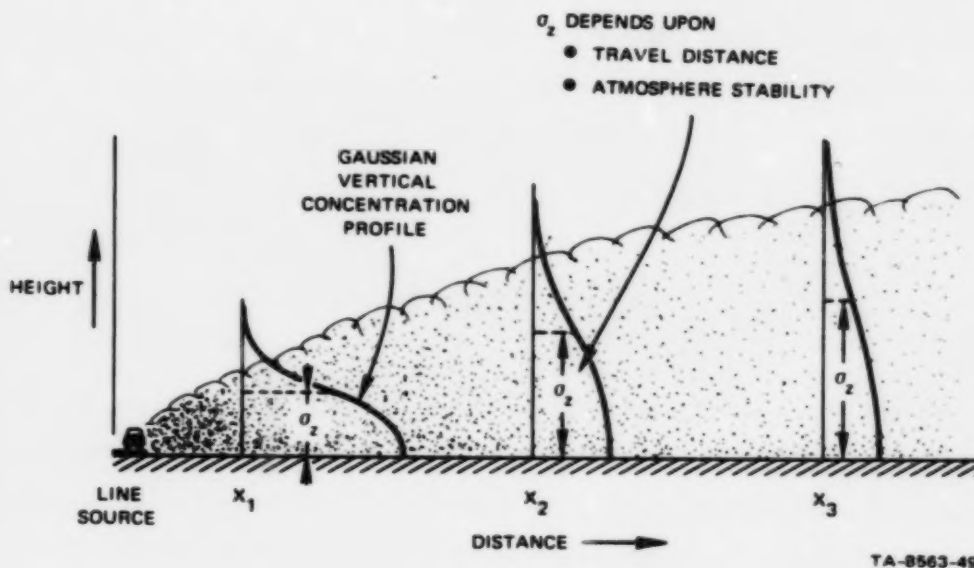


FIGURE 5 VERTICAL DIFFUSION ACCORDING TO GAUSSIAN FORMULATION

is characterized by its standard deviation, σ_z . On the basis of experimental data, σ_z is taken to have the form

$$\sigma_x = ax^b, \quad (2)$$

where x is the downwind distance, and a and b are parameters that depend on the atmospheric stability (see Johnson et al., 1971, Section V-D). The contributions from one of the upwind area sources to the CO concentration (C) at the receptor are then given by

$$\left(\frac{C}{Q_A}\right)_{ij} = \frac{0.8}{ua_{ij}} (1 - b_{ij})^{-1} \left(x_{i+1}^{1-b_{ij}} - x_i^{1-b_{ij}} \right), \quad (3)$$

where Q_A is the average area emission rate ($g\ m^{-2}\ s^{-1}$) from the segment, and u is the transport wind speed. The subscript i denotes the different segments; x_{i+1} is the end point and x_i the beginning point of Segment i . The subscript j denotes different stability classes. The model is so formulated that the values of a and b need not be the same for all segments. However, the values currently used in the computer program are functions only of stability class, j , as suggested by urban tracer experiments (Johnson et al., 1971).

A simple "box" model,

$$\left(\frac{C}{Q_A}\right)_i = \frac{x_{i+1} - x_i}{uh}, \quad (4)$$

is applied for distant segments when there is a limiting mixing depth (h) determined by the vertical temperature stratification. Under these conditions, pollutants tend to be distributed uniformly in the vertical after sufficient travel has taken place. A change from the Gaussian model to the box model is made at the distance where the two would give equal values of concentration if applied to a line source.

C. Extraurban Diffusion

The extraurban diffusion calculation is simpler than the intraurban. On the basis of the box-model concept, the CO contributed by extraurban sources (C_e) is estimated from the equation

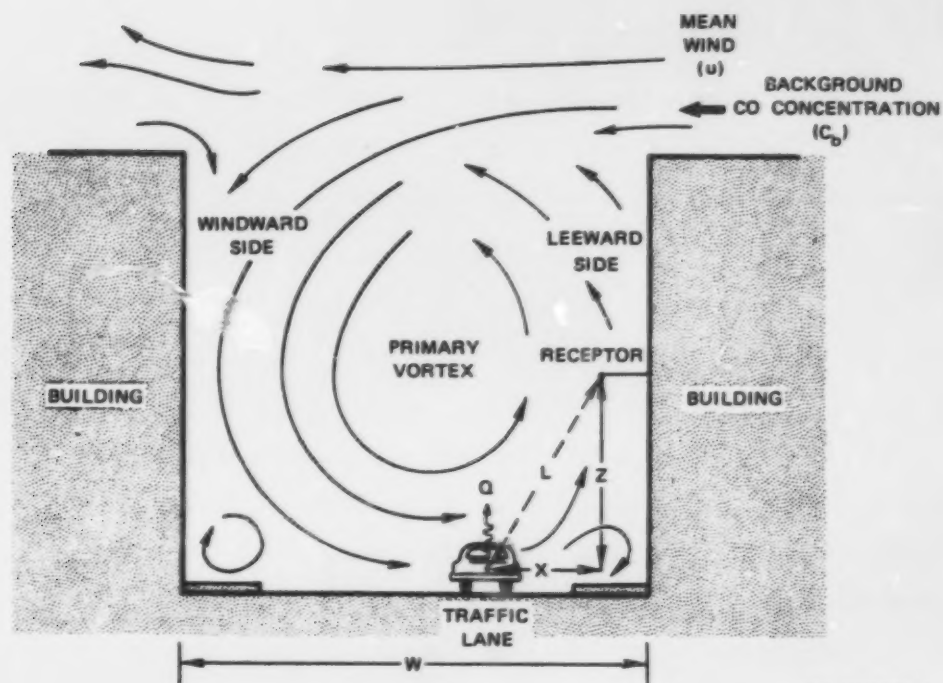
$$C_e = \frac{5.15 \times 10^{-11} F}{u_h} , \quad (5)$$

where F is the annual consumption of fuel (gal yr^{-1}) within a 22.5-degree angular sector extending from 32 to 1000 km upwind of the receptor location. The input for a given city includes a table of 16 values of F that are associated with 16 wind direction categories. These segment fuel consumptions can be calculated from information available in Federal Highway Administration publications. Only one value of C_e is computed for each day, by using a speed and a direction that are representative of the strongest wind observed during the day.

D. Local Street Diffusion

Evidence of a helical air circulation in street canyons, as illustrated in Figure 6, has been observed (see Johnson et al., 1971). Receptors on the leeward side of a building (to the right side as shown in Figures 6 and 7) are exposed to substantially higher concentrations than are those on the windward (left) side because of the reverse flow component across the street, near the surface. Thus, the concentration (C) at a receptor may be considered as having two superimposed components. One component is the concentration (C_b) of the air entering the street canyon from above. (It is assumed that the concentration computed by the extraurban and intraurban diffusion models represents C_b). The other component (ΔC) arises from the locally generated CO emissions within the street. Hence, we have

$$C = C_b + \Delta C \quad . \quad (6)$$



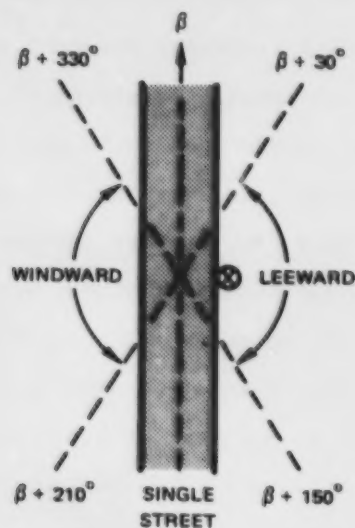
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FIGURE 6 SCHEMATIC OF CROSS-STREET CIRCULATION BETWEEN BUILDINGS

Equations for calculating the ΔC components on both the leeward side (ΔC_L) and the windward side (ΔC_W) were derived by Johnson et al. (1971) and modified by Ludwig et al. (1972). The leeward component is calculated by

$$\Delta C_L = \frac{K Q_s}{(u + 0.5) \left[\left(x^2 + z^2 \right)^{1/2} + L_o \right]} \quad (7)$$

In this equation, K is an empirical nondimensional constant ($K \approx 7$); L_o is a dimension representing the vehicle size ($L_o \approx 2$ m); and x and z are the horizontal and vertical distance of the receptor relative to the center of the traffic lane (see Figure 6). Also, u is the rooftop wind speed (ms^{-1}), generally estimated from the airport wind speed U_a by a regression relationship, and Q_s is the average rate of emission of CO



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FIGURE 7 SPECIFICATION FOR LEEWARD AND WINDWARD CASES ON THE BASIS OF RECEPTOR LOCATION, STREET ORIENTATION, AND WIND DIRECTION

($\text{g m}^{-1} \text{s}^{-1}$) in the street. Values of Q_s are computed by multiplying the street's daily traffic volume by the hourly traffic factor (P_t) and the vehicle emission rate (E), and by converting the units. The windward-side component (ΔC_W) is calculated by

$$\Delta C_W = \frac{K Q_s (H - z)}{W(u + 0.5)H} \quad , \quad (8)$$

where W is the street width, and H is the average building height. When the wind direction is such that neither a leeward nor a windward case is appropriate, an intermediate concentration (ΔC_I) is calculated by combining the above two equations,

$$\Delta C_I = 1/2 (\Delta C_L + \Delta C_W) \quad . \quad (9)$$

E. Transport Wind, Mixing Depth, and Stability Index

The meteorological input variables required for the model are the transport wind direction and speed, the mixing depth, and the atmospheric stability type. The model is designed to be generally applicable to any city where conventional airport weather observations might be the only observations available. Thus, the airport surface wind speed and direction are used to estimate the transport wind. Special methods were developed to calculate the mixing depth and stability index from the available meteorological observations. The method used for the mixing-depth calculation is based on the U.S. Weather Service's nearest morning (1200 GMT), upper air temperature sounding. This sounding, together with the maximum afternoon temperature at the surface, permits the afternoon or maximum mixing depth to be calculated. The morning or minimum mixing depth is calculated by using a simple urban model and an empirical relationship involving city size and urban and rural nighttime temperatures. Hourly mixing depths are then interpolated on the basis of the observed hourly surface temperatures for the daylight and premidnight hours; mixing depth is assumed to be constant between the hours of midnight and dawn. The method used to determine the stability index depends on prevailing insolation and wind speed during daylight hours and on cloud amount (opaque) and wind speed during nighttime hours.

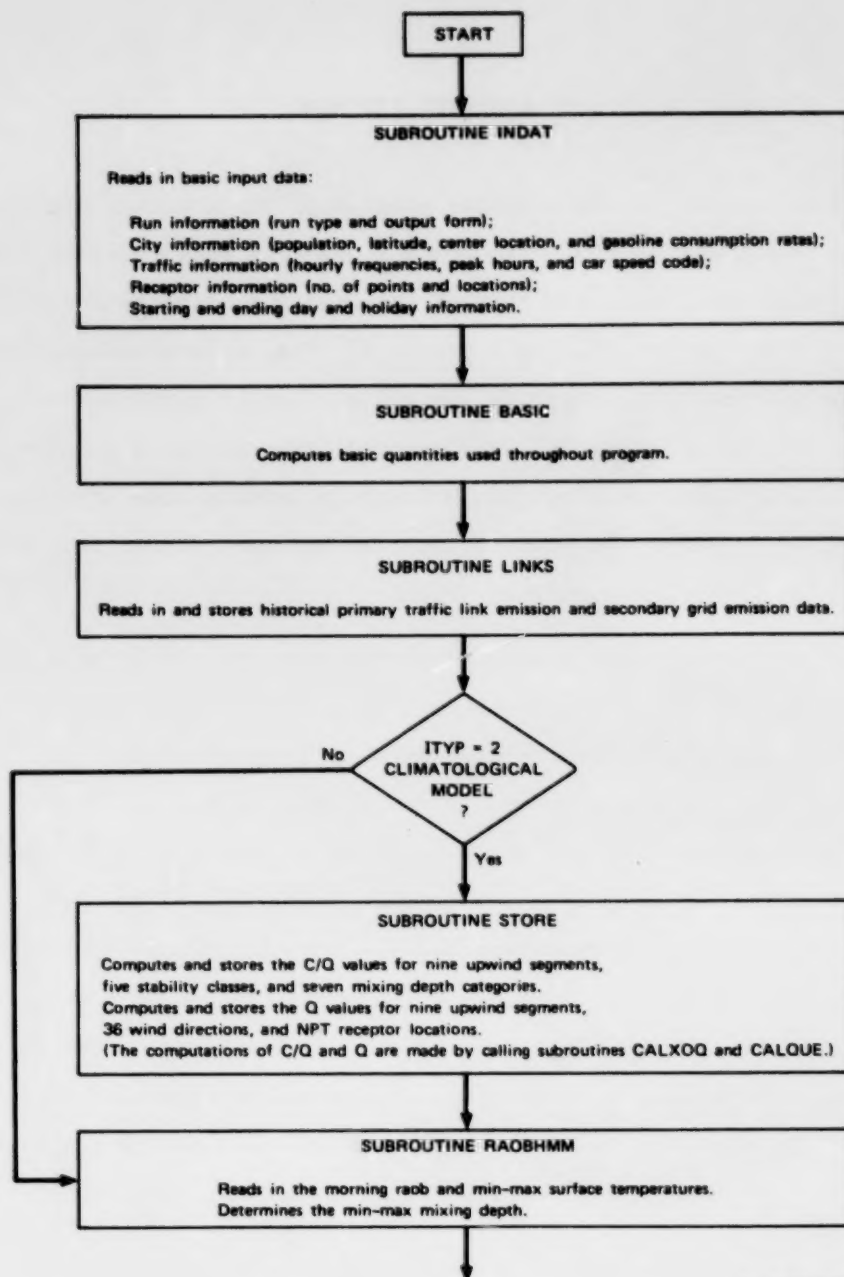
IV COMPUTER PROGRAM

A flow diagram of the computer program of the APRAC-1A diffusion model is shown in Figure 8. The program was originally written for a CDC 6400 computer, and a CDC FORTRAN (Version 2.1) listing compatible with that computer is given in Appendix A. The program was revised by D. H. Coventry and R. E. Ruff of the EPA so that it could be run on that Agency's IBM 360/50 computer. The revised IBM-compatible program listing is given in Appendix B. Both these listings contain some programming statements that have been used for special purpose calculations but are by-passed in the current configuration.

The program has been organized in the form of several subprograms. Some of these subprograms are designed to convert conventional meteorological observations to the requirements of the model, that is, to stability index or mixing depth. By using subprograms for these purposes, changes can be made with minimum disruption of the rest of the program. Thus, if future research provides better methods for determining stability index, the user can incorporate these new methods relatively easily. Similarly, the local street-canyon effects are treated in a separate subprogram that can be changed or replaced as knowledge of the phenomenon increases. The program has been designed to be as practical as possible in regard to the data that it requires and the ease with which it can be modified to incorporate the results of continuing research.

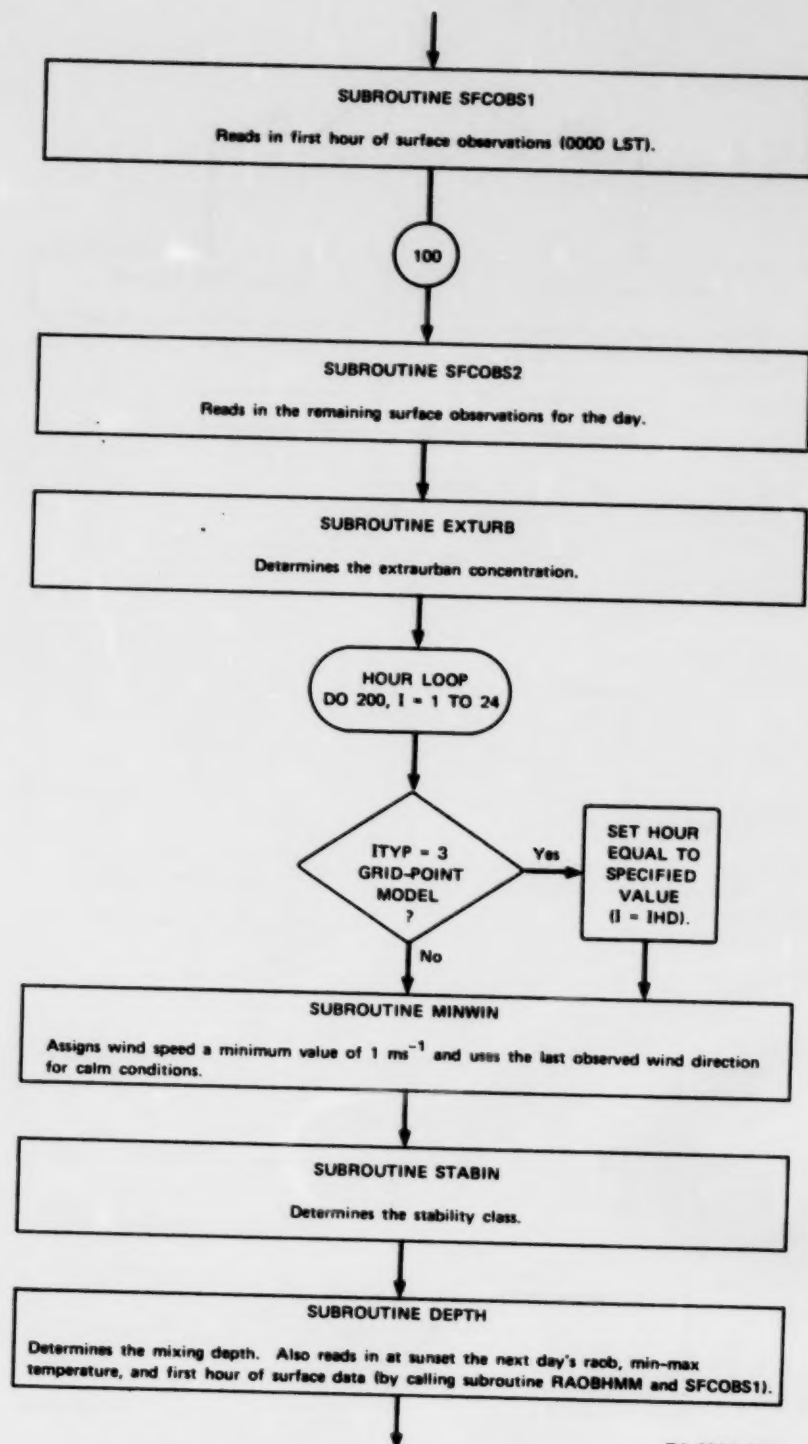
A. Program Usage

Three versions of APRAC-1A are included in this program: the synoptic, climatological, and grid-point models.



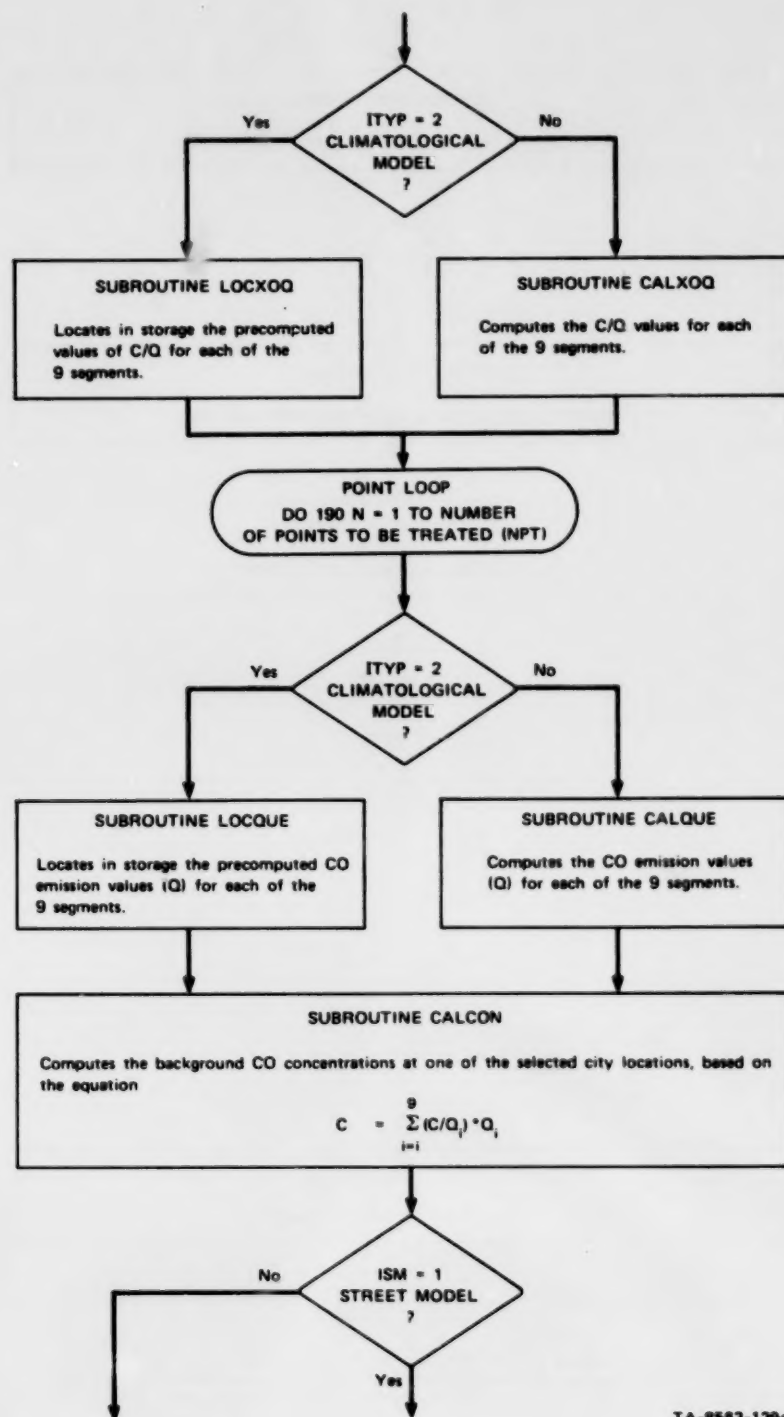
TA-8563-129a

FIGURE 8 APRAC-1A FLOW CHART



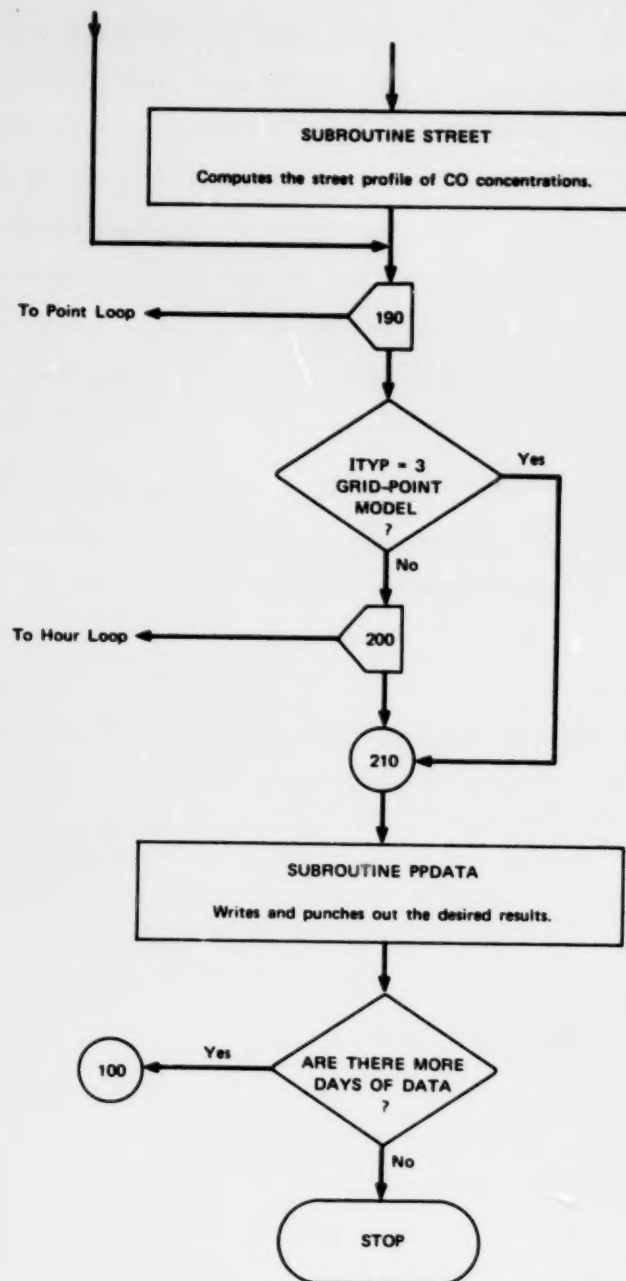
TA-8563-129b

FIGURE 8 APRAC-1A FLOW CHART (Continued)



TA-8583-129c

FIGURE 8 APRAC-1A FLOW CHART (Continued)



TA-8563-129d

FIGURE 8 APRAC-1A FLOW CHART (Concluded)

The synoptic and climatological models use the hour-by-hour values of meteorological and traffic input data to make hourly CO computations for a limited number (one to ten) of receptor locations within the city. In the climatological model the major computations are made once and are then stored in data arrays. The climatological model is more efficient than the synoptic model when the number of CO computations per receptor exceeds about 50 (or about two days of hourly computations). The synoptic model is useful in an operational or evaluational sense, whereas the climatological model is designed primarily as a tool for use in street and freeway planning operations.

The grid-point model permits CO computations for as many as 625 points spaced selectively throughout the city. If this model is used, the computations are restricted to one specified hour of the day, and the street profile computations are automatically bypassed. Thus, the grid-point model has limited use, but it is valuable for portraying a horizontal pattern of CO concentration over an entire city, which would be closely representative of background or rooftop values.

B. Data Input

Various basic information is specified on cards denoted as A through M, as given in Table 3 and also in Appendix C. Card A is used to specify values for ITYP, ISM, NPT, IOUT(1), IOUT(2) and IOUT(3). The run type is determined by giving ITYP a value of 1 (synoptic), 2 (climatological), or 3 (grid point). The street model is used if ISM is set equal to 1 and not used if it is set to 0. Also, if line-printer, punch-card, or magnetic tape output is desired, the corresponding variable, IOUT(1), IOUT(2), or IOUT(3), is set equal to 1; if not, it is set to 0. The number of receptor points (NPT) for which concentrations are to be calculated is also specified on Card A. However, the receptor locations and information pertaining to the streets on which the receptors are

Table 3

BASIC INPUT INFORMATION: CARDS A THROUGH M
(Data Read-in by Subroutine INDAT)

Card	Column	Format	Symbol	Units	Value Limits	Typical Value	Description
A	1-10	I10	ITYP	--	1, 2, or 3	1	Run type indicator: 1 = synoptic model 2 = climatological model 3 = grid-point model
	11-20	I10	ISM	--	0 or 1	1	Street model indicator: 0 = exclude street model 1 = include street model
	21-30	I10	NPT	--	1 to 10 if ITYP = 1 or 2 1 to 625 if ITYP = 3	2	Number of receptor points to be treated
	31-40	I10	IOUT(1)	--	0 or 1	1	Line-printer output: 0 = no 1 = yes
	41-50	I10	IOUT(2)	--	0 or 1	0	Card-punch output: 0 = no 1 = yes
	51-60	I10	IOUT(3)	--	0 or 1	0	Magnetic-tape output: 0 = no 1 = yes
B(1) I = 1, NPT	1-20	2F10.4	XPT(1), YPT(1)	0.01 mi (from arbitrary origin)	0 to 10 ⁵	1997.0, 2071.0	NPT cards giving the: Receptor x and y locations
	21-30	F10.4	AST(1)	Degrees from north	0 to 360	17.0	Direction of the street on which receptor is located
	31-40	F10.4	VCAR(1)	Vehicles per day	≥ 0	6000.0	Number of vehicles per day on the receptor street
	41-50	F10.4	WWST(1)	Meters	> 0	24.3	Receptor street width*
	51-60	I10	ICST(1)	Number	1 to 8	6	Traffic code number of receptor street
	61-70	I10	NQCD(1)	Number	> 0	1 (first card in deck)	Card order number of receptor street in traffic input data deck (Table 3).

* In this current version of the computer program, the average building height (H in text and Z3 in program) has been set fixed at 36.6 meters in a data declaration of subroutine STREET.

Table 3 (continued)

Card	Column	Format	Symbol	Units	Value Limits	Typical Value	Description
C	1-10	F10.4	SLAT	Degrees of latitude	0 to 90	38.6	City latitude
	11-20	F10.4	PQP	Millions of people	0 to 10	2.36	City population
	21-40	2F10.4	XYT, YVT	0.01 mi	0 to 10 ⁵	1931.5, 2040.5	City center location
	41-50	F10.4	CLE	Percent	0 to 100	5.0	City's total amount of secondary traffic, equal to CLE percent of primary traffic
	51-60	F10.4	PF1	--	> 0	700.0	Value for α } emission constants
	61-70	F10.4	PG1	--	< 0	-0.75	Value for β }
D(1) and D(2)	1-80	8F10.4	FUEL (1) I = 1, 16	Millions of gallons per year	> 0	11.02 (I = 1)	Two cards giving the gasoline consumption rate as a function of 16 angular sectors
	1-80	8F10.4	S (1) I = 1, 8	mi h ⁻¹	> 0	43.0 (I = 1)	Car speeds for up to eight road types
F(1), F(2), and F(3)	1-80	8I10	KT(1) I = 1, 24	--	1 or 2	1 (I = 8)	Three cards indicating whether each hour of the day is a peak or off-peak traffic hour 1 = peak hour 2 = off-peak hour
	1-80	8F10.4	PT12(1) I = 1, 24	Fraction	0 to 1	0.0726 (I = 8)	Three cards giving the fraction of the daily traffic within each of the 24 hours, for weekdays, and for Road Types 1 and 2
H(1), H(2), and H(3)	1-80	8F10.4	PT34(1) I = 1, 24	Fraction	0 to 1	0.064 (I = 8)	Same as above, except for Road Types 3, 4, and 5
I(1), I(2), and I(3)	1-80	8F10.4	PT6(1) I = 1, 24	Fraction	0 to 1	0.0726 (I = 8)	Same as above, except for street model
J(1), J(2), and J(3)	1-80	8F10.4	PTSAT(1) I = 1, 24	Fraction	0 to 1	0.054 (I = 8)	Same as above, except for Saturdays and for all road types
K(1), K(2), and K(3)	1-80	8F10.4	PTSUN(1) I = 1, 24	Fraction	0 to 1	0.018 (I = 8)	Same as above, except for Sundays and holidays and for all road types

Table 3 (concluded)

Card	Column	Format	Symbol	Units	Value Limits	Typical Value	Description
L	1-10	I10	IDATE	Date	--	710826	Beginning date (26 August 1971)
	11-20	I10	IDATE9	Date	≥IDATE	710926	Ending date (26 September 1971)
	21-30	I10	IDW	Day of week	1 to 7	4 (Thursday)	Day of the week for beginning date
	31-40	I10	IHD	Hour	1 to 24	8	Hour of day to be treated in grid-point model (ITYP = 3)
	41-50	I10	NH	Number	≥0	1	Number of holidays
M(I) I = 1, NH	1-10	I10	NHDL(I)	Date	IDATE to IDATE9	710906 (Labor Day)	NH cards giving the date of the holidays

located are specified on B cards (one card for each location). Information pertaining to the city, such as population, latitude, city-center location, secondary emission amount, and emission constants (α and β), is given on Card C. Gasoline consumption rates for 16 different angular sectors are given on Cards D(1) and D(2). These data are used to compute the extraurban contribution to the CO concentration. Vehicle-speed, peak-hour, and hourly traffic distribution information is specified on Cards E through K, as given in Table 3. The beginning and ending days of the period to be analyzed and the number of holidays during the period are specified on Card L. The dates of the holidays are given on the M cards, one card for each holiday.

The primary and secondary traffic data are specified on the N and Ø cards, as shown in Table 4. The primary traffic data are given by individual links, with a separate card for each link. The read-in of the traffic link data cards is terminated when a card with a 9 in Column 1 is detected; however, the number of these cards should not exceed 1200. The secondary traffic data are given for grid points spaced 2 mi apart. There is a separate Ø card for each grid point; each Ø card contains the x and y location of the grid point and the percentage of the city's total secondary emission that falls within the 4-mi² area surrounding the point. The total amount of secondary traffic is set equal to the percent of the total primary traffic (CLE) that is specified on Card C. The read-in of this secondary emission data is also terminated when a card with a 9 in Column 1 is detected.

Meteorological data are specified on Cards P, Q, and R, as shown in Table 5. Card P, a header card, contains the city's name, the date, and the daily maximum and minimum temperatures. This card also contains an indicator of whether it is a day when there is a time change. The program initially assumes local standard time (LST). Thus, if the first day is during a daylight saving period, Card P should always include

Table 4

TRAFFIC INPUT DATA: CARDS N AND Ø
(Data Read-in by Subroutine LINKS)

Card	Column	Format	Symbol	Units	Value Limits	Typical Value	Description
N(I) I = 1, Indef*	11-20	2F5.0	X1L, Y1L	0.01 mi	0 to 10 ⁵	1395, 1825	An indefinite number of cards giving the: (x, y) location of one end of the link
	21-30	2F5.0	X2L, Y2L	0.01 mi	0 to 10 ⁵	1355, 1790	(x, y) location of the other end of the link
	31-36	F6.0	VV	Vehicles per day	≥ 0	28000	Number of vehicles per day on link
	37-41	I5	IF	Number	1 to 5	3	Traffic code number
	42-46	I5	LL	0.01 mi	0 to 10 ⁵	55	Length of link
Ø(I) I = 1, Indef*	11-30	2I10	IX, IY	0.01 mi	0 to 10 ⁵	1300, 1500	An indefinite number of cards giving the: (x, y) location of grid points spaced at 2-mile intervals
	31-40	I10	IZ	Percent	0 to 100	2	Percent of the city's total secondary traffic that is occurring within the 4-mi ² area surrounding the grid point

* The read-in of both the N and Ø cards is terminated by a card with a 9 in Column 1 (the number of N cards should not exceed 1200).

Table 5

METEOROLOGICAL INPUT DATA: CARDS P, Q, AND R
(Data Read-in Repeatedly by Subroutines RAGBMM, SFCBMS1, and SFCBMS2)

Card	Column	Format	Symbol	Units	Value Limits	Typical Value	Description
P	1-10	A10	ISTA	--	--	ST. LOUIS	City name
	11-20	I10	IDAT	Date	--	710826	Date (26 August 1971)
	21-25	I5	MAXT	°F	--	83	Maximum temperature for day
	26-30	I5	MINT	°F	--	59	Minimum temperature for day
	31-35	I5	IDSC	Hour	-1, 0, +1	1	Indicator of time change from previous day: -1 = daylight saving to standard time 0 = no change +1 = standard to daylight savings time (standard time assumed initially)
Q(I) I = 1, indef.	23-26	F4.1	T(I)	°C	--	-9.5	An indefinite number of cards giving the temperature and pressure sounding data for both significant and standard levels. The read-in terminates when the 500 mb data card has been read.
	40-44	F5.1	P(I)	Millibars	≥ 500	500.0 (I = 11)	
R(I) I = 1, 24	7-10	I4	IHR(I)	Hour	0 to 23	23	24 cards giving the surface data information from 0000 LST to 2300 LST
	11-15	I5	ICLD(I)	Tenths	0 to 10	0	
	16-20	I5	ITEMP(I)	°F	--	60	
	26-30	I5	IWD(I)	Tens of degrees from north	0 to 36	36	
	31-35	F5.0	WS(I)	Knots	≥ 0	7 (I = 24)	

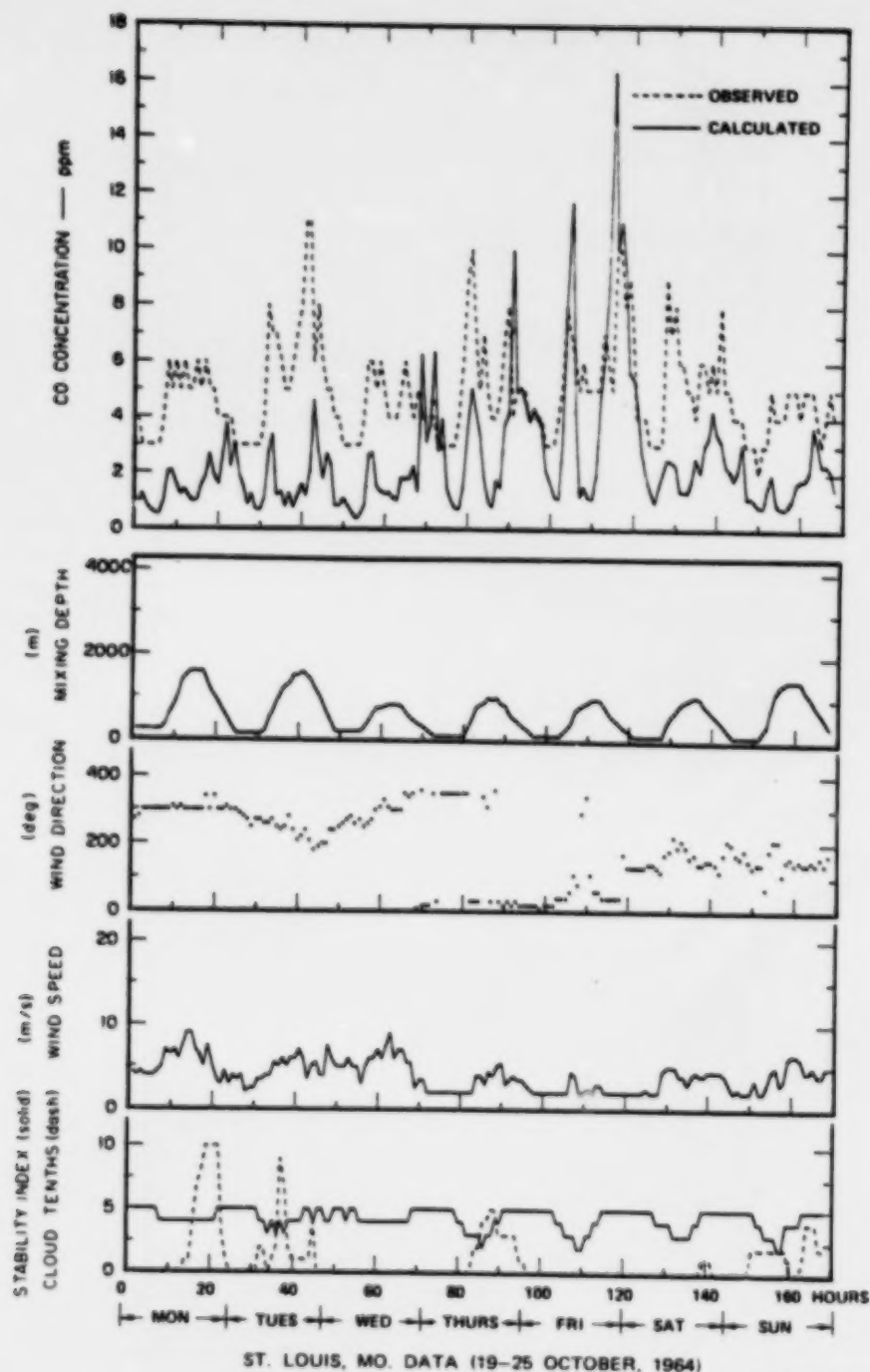
an indication of a +1-hour change from standard to daylight time. Cards Q and R contain the 1200 GMT radiosonde (raob) data and the hourly surface data. The raob data include both significant and standard levels from Card Deck Format 505 of the National Climatic Center (see footnote of Section II). There is a separate Q card for each level, and the last card must always be for the 500-mb level, since this terminates the reading of data. The surface data are specified for each hour of the day, beginning at 0000 LST and ending at 2300 LST; there is a separate R card for each hour. The program reads in a separate set of the P, Q, and R cards for each day until the CO computations have been completed through the specified ending date. The P and Q cards and the first R card (surface data for hour zero) for the day following the ending date must be included at the end of the data deck.

C. Data Output and Program Capabilities

The calculated CO concentrations can be output on the line printer, on punch cards, or on magnetic tape, depending on the values assigned to IOUT(1), IOUT(2), and IOUT(3). An example of the synoptic model's CDC 6400 line-printer output is shown in Appendix D. (This output was produced by the data input shown in Appendix C). The line-printer output for the climatological model and that for the grid-point model have basically the same format; however, one would normally desire only punch-card or magnetic-tape output when using these two models. The computed CO concentrations (ppm) always include the background value (C_b). When ISM is set equal to 1, the low-level (3.65-m) and high-level (22.8-m) concentrations are calculated for both the right and left sides of the street (facing in the street direction specified on Card B). The outputs also include the hourly values of cloud amount (tenths), surface temperature ($^{\circ}\text{K}$), wind direction (degrees), wind speed (ms^{-1}), stability index, and mixing depth (m).

Punch-card or magnetic-tape output from this program can be used as the input data into the computer to produce graphic displays. Graphic displays of the various outputs are very useful. For example, in evaluating the performance of the synoptic model, extensive comparisons were made of the calculated hourly concentrations (C_b) with the values observed at CAMP stations in Chicago, St. Louis, Denver, Cincinnati, and Washington, D.C. One of the graphic comparisons for St. Louis is shown in Figure 9. Also shown in Figure 9 are the graphic displays of the mixing depth, stability index, cloud amount, and wind direction and speed. Frequency distributions of CO concentrations for various different times of day at the St. Louis CAMP station are shown by graphic display in Figure 10. These results were obtained from the output of the climatological model. An example of computer contouring based on 625 grid-point values is presented in Figure 11(a). The road or link network that was used is shown as an underlay. Figure 11(b) illustrates the telescoping grid or "zoom" capability of the grid-point model; that is, the grid spacing was reduced by a factor of ten to depict the detailed concentration pattern of downtown St. Louis.

As noted earlier, the APRAC-1A program was originally written in CDC FORTRAN Version 2.1 for use on the SRI CDC 6400 computer. It has been modified for use on an IBM 360/50, but further modification of the program may be necessary if it is to be used with other types of computers. The central processing times on the CDC 6400 computer for the synoptic, climatological, and grid-point models are given in Table 6. The storage requirement of the program is 45,000 words of memory, although this would need to be increased for cities larger than St. Louis.



TA-7874-49R

FIGURE 9 METEOROLOGICAL INPUTS TO THE MODEL WITH OBSERVED AND CALCULATED CO CONCENTRATIONS AT THE ST. LOUIS CAMP STATION. The calculated concentrations shown here are generally underestimates because they do not include the contributions from the local street.

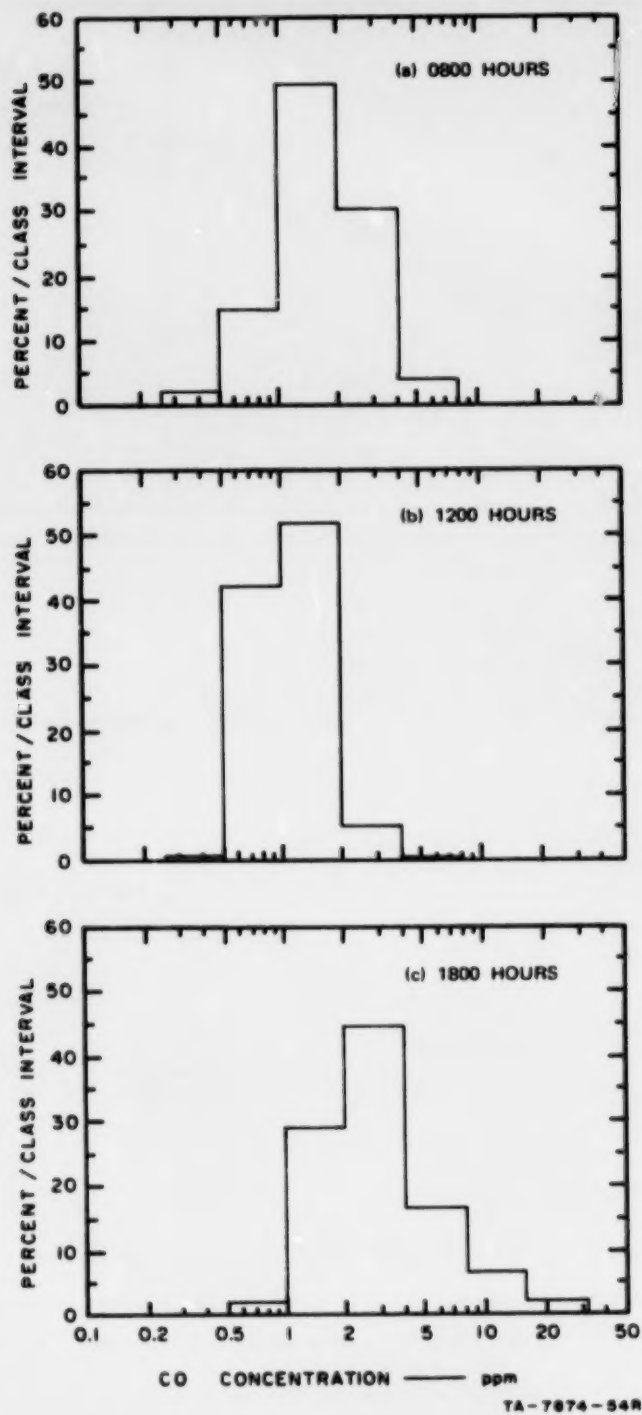
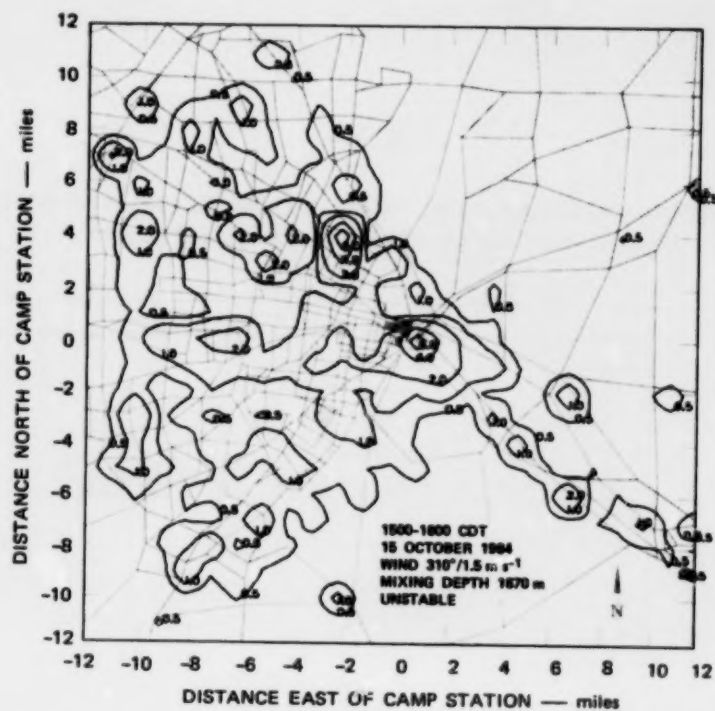
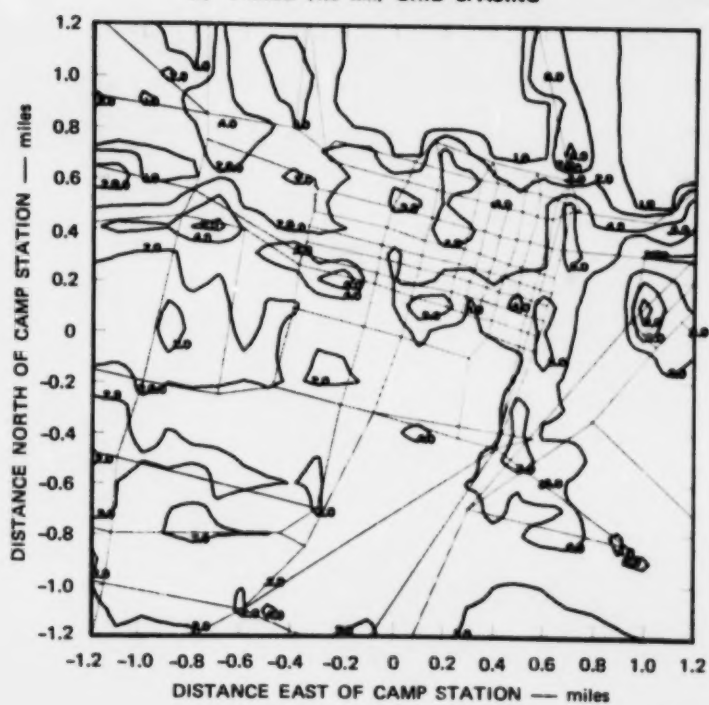


FIGURE 10 CALCULATED ST. LOUIS CAMP STATION CO CONCENTRATION FREQUENCY DISTRIBUTION FOR 1965 TRAFFIC CONDITIONS; 0800, 1200, AND 1800 HOURS



TA-7874-26

(a) 1-MILE (1.6 km) GRID SPACING



TA-7874-24

(b) 0.1-MILE (0.16 km) GRID SPACING

FIGURE 11 CALCULATED ST. LOUIS CONCENTRATION PATTERNS FOR TWO GRID SIZES

Table 6

APRAC-1A CENTRAL PROCESSOR TIME (SECONDS) ON THE SRI CDC 6400 COMPUTER*
 (For computing CO concentrations in St. Louis)

Process	Model			
	Synoptic		Climatological	Grid-Point
	One Receptor (NPT = 1)	More Than One Receptor (NPT > 1)		
Compilation	10.5	10.5	10.5	10.5
Preliminary computation	6.1	5.9	$5.9 + 7.5 \times \text{NPT}$	5.9
Basic computation (per recep- tor per hour)	1.14×10^{-1}	2.25×10^{-1}	3.7×10^{-3}	2.85×10^{-1}

* This computer has an add time of 1.1 microsecond and a cycle time of 1.0 microsecond.

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- Ludwig, F. L., and W. F. Dabberdt, 1972: "Evaluation of the APRAC-1A Urban Diffusion Model for Carbon Monoxide," Final Report, Contract CAPA-3-68(1-69), Stanford Research Institute, Menlo Park, California, 167 pp.
- Ott, Wayne, 1972: "An urban survey technique for measuring the spatial variation of carbon monoxide concentrations in cities." APCA Paper No. 72-17, 65th Annual Meeting of the Air Pollution Control Association, Miami Beach, Florida.

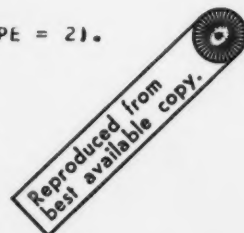
Appendix A

SRI CDC 6400 VERSION OF APRAC-1A COMPUTER PROGRAM

```

C      PROGRAM APRACIA(INPUT,OUTPUT,PUNCH,TAPE41)
C
C      AIR POLLUTION DIFFUSION MODEL
C
C      THIS PROGRAM COMPUTES THE CO CONCENTRATIONS AT VARIOUS CITY
C      LOCATIONS BASED ON TRAFFIC AND METEOROLOGICAL INPUT DATA.
C
C      SET ITP EQUAL TO
C          1 FOR SYNOPTIC MODEL
C          2 FOR CLIMATOLOGICAL MODEL
C          3 FOR GRID PT MODEL.
C
COMMON/CITY/ ITP,ISM,IOUT(10)
COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON/CSTM/ VCAR(10),AST(10),WWST(10),ICST(10),NOC(10)
COMMON/CHANG/ HANG,ACV
COMMON /CORD/ XXC,YYC
COMMON /DAY/ IDW,NH,IDAHO,IHW,IDWT
COMMON/CSTAB/ SPI80,CP180
COMMON/CFUEL/ FUEL(16),NHOL(10)
COMMON/CPFC/ PFI,PF2,PO1,PO2,S(9),KT(24)
COMMON /MIX/ ISTA,IYR,IMO,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,IDATE9
COMMON /HMM/POP4,P(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
COMMON /CAR/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
COMMON /QUE/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),XOQ(10)
COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
COMMON/CSAV/ JS,L7,I9,K36,HMI,SXOQ(320),SQ12(3240),SQ34(3240),
1      SQL(3240)
COMMON /CLOQ/ VCL(2500),VCM(2500),CH(3),SB(3),NRW,NCL,MRW,MCL,CLE,
IGSP,RGS,ZQX
COMMON/CLDAT/IFK(1200),X1(1200),X2(1200),Y1(1200),Y2(1200),E(1200)
COMMON /ALLC/ YS(351),IYN(351)
1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XMC,
2YRC,XC2,BY2,BY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
1 FORMAT (1H1,55X,*SYNOPTIC AIR POLLUTION MODEL*/)
2 FORMAT(1H1,52X,*CLIMATOLOGICAL AIR POLLUTION MODEL*/)
3 FORMAT (1H1,53X,*GRID POINT AIR POLLUTION MODEL*/)
C
C      INPUT THE BASIC PARAMETERS.
C      CALL INDAT
C      IF (ITYP.EQ.1) PRINT 1
C      IF (ITYP.EQ.2) PRINT 2
C      IF (ITYP.EQ.3) PRINT 3
C
C      COMPUTE THE EMISSION FACTOR AND OTHER INITIAL QUANTITIES.
C      CALL BASIC
C
C      INPUT THE MAJOR AND MINOR TRAFFIC EMISSION DATA.
C      CALL LINKS
C
C      PRECOMPUTE AND STORE ALL THE X/Q AND Q VALUES (IF ITP = 2).
C      IF (ITYP.EQ.2) CALL STORE
C
C      INPUT THE HEADER CARD AND RAOB OBSERVATIONS AND
C      DETERMINE THE MIN-MAX MIXING DEPTH FOR THE FIRST DAY.

```



```

      CALL RAOBHHM
C
C      INPUT THE FIRST SFC OBS CARD.
      CALL SFCOBS1
C
C      INPUT THE REMAINING SFC OBS FOR THE DAY.
100 CALL SFCOBS2
C
C      DETERMINE THE EXTRAURBAN CO CONTRIBUTION.
      CALL EXTURB (EXTRAQ)
C
C      BEGIN HOUR LOOP
      DO 200 I=1,24
C
C      IN GRID POINT MODEL THE COMPUTATION IS DONE FOR HOUR IHD ONLY.
      IF (ITYP.EQ.3) I=IHD
C
C      DETERMINE THE MINIMUM WIND SPEED AND DIRECTION.
      CALL MINWIN (I)$ (WI=IWD(I))
C
C      DETERMINE THE STABILITY INDEX.
      CALL STABLE(I,SAS,IJ)
C
C      DETERMINE THE MIXING DEPTH AND AT SUNSET INPUT THE HEADER
C      CARD, THE RAOB DATA, AND THE FIRST FOUR HOURS OF SFC DATA
C      FOR THE NEXT DAY.
      CALL DEPTH (I,SAS,HT)
C
C      DETERMINE THE X/Q VALUES USING THE GAUSSIAN AND BOX MODELS.
      IF (ITYP.EQ.2) 140,150
C
C      SELECTS APPROPRIATE X/Q VALUES FROM STORAGE.
140 CALL LOCXQ(HT,IJ)$ GO TO 160
C
C      COMPUTE APPROPRIATE X/Q VALUES.
150 CALL CALXQ(HT,IJ)
C
C      BEGIN POINT LOOP
160 DO 190 N=1,NPT
C
C      DETERMINE THE Q VALUES FROM TRAFFIC EMISSION DATA.
      IF (ITYP.EQ.2) 170,180
C
C      SELECTS APPROPRIATE Q VALUES FROM STORAGE.
170 CALL LOCQE(IWI,N)$ GO TO 189
C
C      COMPUTE APPROPRIATE Q VALUES.
180 CALL CALQE(IWI,N)
C
C      DETERMINE THE TOTAL BACKGROUND CO CONCENTRATION.
189 CALL CALCON (I,N,HT,EXTRAQ)
C
C      DETERMINE THE STREET PROFILE CO CONCENTRATIONS IF ISM IS
C      NOT EQUAL TO ZERO.
      IF (ISM.NE.0) CALL STREET(I,N)
C

```

```

190 CONTINUE
   IF (ITYP.EQ.3) GO TO 210
200 CONTINUE
210 CONTINUE
C
C      PRINT AND PUNCH THE DESIRED PARAMETERS.
C      CALL PPDATA
C
C      DAY OF THE WEEK CHECK.
   IF (INH.EQ.0) GO TO 300
   IF (IDAHO.EQ.0) GO TO 295
   IDAHO=08  NH=NH-1
295 IF (IDATE1.EQ.NHOL(NH)) IDAHO=1
300 IDW=IDW+1
   IF (IDW.LT.8) GO TO 400
   IDW=IDW-18  IC=0
C
C      CHECK FOR THE END OF THE TIME PERIOD.
400 IF (IDATE1.LE.IDATE9) GO TO 100
500 STOP $ END

```

```

C      SUBROUTINE INDAT
C THIS SUBROUTINE READS IN BASIC DATA
C
COMMON/CITY/ ITYP,ISM,IOUT(10)
COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON/CSTM/ VCAR(10),AST(10),MWST(10),ICST(10),NUCD(10)
COMMON /CORD/  XXC,YYC
COMMON/CSTAB/ SP180,CP180
COMMON /DAY/  IDW,NH,IDAHO,IHW,IDWT
COMMON/CPFC/  PF1,PF2,PO1,PO2,S(9),KT(24)
COMMON/CFUEL/      FUEL(16),NHOL(10)
COMMON /MIX/  ISTA,IYR,IHO,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,IDATE9
COMMON /GRAF/  I1(7),IA(24),IB(16,8),IV(5,8),IGS
COMMON /HMM/POP4,P(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
COMMON /CAR/  PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
COMMON /PNT/  IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
COMMON /CLOQ/ VCL(2500),VCM(2500),CB(3),SB(3),NRW,NCL,MRW,MCL,CLE,
IGSP,RGS,ZQX
COMMON/CN24/  N24
1  FORMAT(8I10)
3  FORMAT(8F10.4)
4  FORMAT(5F10.4,2I10)
5  FORMAT(2F10.4)
READ 1,ITYP,ISM,NPT,(IOUT(I),I=1,5)
IF (ITYP.GT.2) GO TO 15
READ 4,(XPT(I),YPT(I),AST(I),VCAR(I),MWST(I),ICST(I),NUCD(I),
2  I=1,NPT)
GO TO 17
15 ISM=0
READ 5,(XPT(I),YPT(I),I=1,NPT)
17 READ 3,SLAT,POPS,XXT,YYT,CLE,PF1,PO1
READ 3,(FUEL(I),I=1,16)
READ 3,(S(I),I=1,8)
READ 1,(KT(I),I=1,24)
READ 3,(PT12(I),I=1,24)
READ 3,(PT34(I),I=1,24)
READ 3,(PT6(I),I=1,24)
READ 3,(PTSAT(I),I=1,24)
READ 3,(PTSUN(I),I=1,24)
READ 1,IDATE,IDATE9,IDW,IHD,NH
IF (INH.GT.0) READ 1,(NHOL(I),I=1,NH)
IF (ITYP.LT.2.AND.NPT.GT.10) NPT=10
N24=24$ IF (ITYP.LT.3) GO TO 19$ N24=1$ ISM=0
19 DO 20 I=1,9
20 IF (S(I).LT.1.0) S(I)=99.0
XXC=-XXT$ YYC=-YYT
DO 30 I=1,NPT$ XPT(I)=XPT(I)+XXC
30 YPT(I)=YPT(I)+YYC
POPS=POPS*1.0E6$ POP4=SQRT(SQRT(POPS))
IGS=IHW$ IC=IHW-1$ IDAHO=0$ SAP=-1.0
ACR=0.0174533
PL180=ACR*SLAT $ SP180=SIN(PL180) $ CP180=COS(PL180)
PF1=PF1/3600.0
RETURN$ END

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      SUBROUTINE BASIC
C
C THIS SUBROUTINE COMPUTES BASIC QUANTITIES USED THROUGHOUT PROGRAM
C
      COMMON/CHANG/ HANG,ACV
      COMMON/CPFC/ PF1,PF2,PO1,PO2,S(9),KT(24)
      COMMON /CAR/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
      COMMON ,ALLC/ YS(351),IYN(351)
      1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2YRC,XC2,BY2,BY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
      DATA ACR,CR,HANG,LRL/0.0174533,62.137,0.196349625,5/
C
C COMPUTES BASIC FACTORS FOR EMISSION MODEL
C   KT(1)=PEAK OR NON PEAK TRAFFIC AT ITH HOUR
C   PT(1)=FRACTION OF DAILY TRAFFIC DURING ITH HOUR
C   EFAC(1)=EMISSION FACTOR FOR ITH FACILITY TYPE
C   S(1)=SPEED FOR ITH FACILITY
C   PO1 AND PF1=INPUT CONSTANTS.
      TN1125=TAN(HANG) $ RR=7.7671 $ CRI=10.0/CR $ ACV=CRI*CRI*1.0E4
      LR4=4 $ LR5=LR4+1 $ LR9=9 $ LR10=LR9+1 $ XP=0.85**PO1
      DO 50 I=1,24
      IF (KT(I).EQ.1) 45,50
45    PT12(I)=PT12(I)*XP $ PT34(I)=PT34(I)*XP $ PT6(I)=PT6(I)*XP
50    CONTINUE
      DO 60 I=1,9
      60 EFAC(I)= PF1*S(I)**PO1
C
C COMPUTES GEOMETRIC QUANTITIES FOR SECTOR SEGMENTS
C   AR(1)=AREA OF ITH SEGMENT
C   YR(1)=MAX DISTANCE OF ITH SEGMENT FROM RECEPTOR
C   XR(1)=MAX HALF WIDTH OF SEGMENT
C   LR4 AND LR9=NO. OF SEGMENTS IN SMALLER AND TOTAL SECTOR.
      DO 210 L=1,LR10 $ AG=11.25$ IF (L.LT.LR5) AG=22.5$ AG=ACR*AG
      TANAG=TAN(AG) $ YR(L)=SQRT(RR*RR*AG/TANAG) $ XR(L)=YR(L)*TANAG
      IF (L.EQ.LRL) YC1=YR(L)
      IF (L.NE.LR4) GO TO 210
      YC2=YR(L)$ XRC= YC2*TN1125 $ XC2=XR(L)$ YRC=YC2
210  RR=RR+RR
      AR(1)=SUMA=XR(1)*YR(1)*ACV
      DO 211 I=2,4
      AR(I)=XR(I)*YR(I)*ACV-SUMA
211  SUMA=SUMA+AR(I)
      SUMA=XRC*YR(4)*ACV
      DO 212 I=5,LR10
      AR(I)=XR(I)*YR(I)*ACV-SUMA
212  SUMA=SUMA+AR(I)
      BY2= TN1125 $ BY1= TAN(ACR*22.5)
      B12=1.0/BY2$ B11=1.0/BY1
      L=1$ DO 213 KO=1,351$ K=KO-1$ K1=K+1$ IF (K.GT.YR(L)*CRI) L=L+1
      YS(K1)=YR(L)$ IYN(K1)=L
213  CONTINUE
      RETURN $ END

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```

      SUBROUTINE LINKS
C
C THIS SUBROUTINE READS IN DATA FOR MAIN AND LOCAL LINKS.
C
      COMMON/CPTS/ NPT,XPT(625),YPT(625)
      COMMON/CTSM/ VCAR(10),AST(10),WWST(10),1CST(10),NDCD(10)
      COMMON /CORD/ XXC,YYC
      COMMON/CHANG/ HANG,ACV
      COMMON/CLDAT/ IFK(1200),X1(1200),X2(1200),Y1(1200),Y2(1200),E(1200)
      COMMON/ALLC/ YS(351),1YN(351)
      1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2YKC,XC2,BY2,BY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LKL
      COMMON /CLOQ/ VCL(2500),VCM(2500),CB(3),SB(3),NRW,NCL,MRW,MCL,CLE,
      1GSP,RGS,ZQX
      DATA GSP,NCL,NRW/100.0,49.49/
      1 FORMAT(11,9X,4F5.0,F6.0,2I5)
      2 FORMAT(11,9X,3I10)
      3 FORMAT (1H ,59X,*NO. OF LINKS =*,15,/)
      MRW=NRW*0.5 $ MCL=NCL*0.5 $ LT=NRW*NCL $ ARI=1.0/(GSP*GSP*ACV)
      RGS=100.0/GSP $ DGS=.05*RGS $ ZQX=0.01*RGS $ CRAD2=YC1*YC1/0.96+1000
      SVL=0.0 $ NCD=0 $ L=1 $ A75=0.833*HANG $ NCD1=NDCD(1)
      XG=XPT(1) $ YG=YPT(1)
      CB(1)=1.0 $ CB(2)=CB(3)=COS(A75)
      SB(1)=0.0 $ SB(2)=SIN(-A75) $ SB(3)=-SB(2)
      DO 75 I=1,LT
      75 VCM(I)=VCL(I)=0.0
C
C READS IN DATA FOR MAIN LINKS
C
      1 LINK DATA STORED IN ARRAYS X1,Y1,X2,Y2,AND E).
      IF (LRL.GE.LR9) 100,120
      100 READ 1,M1,X1L,Y1L,X2L,Y2L,VV,IF,LL
      IF (M1.LT.9) 110,170
      110 VL=VV*LL*0.01 $ SVL=SVL+VL $ EE=EFAC(IF)*VL $ IFK(1L)=IF
      XD=X1L-X2L $ YD=Y1L-Y2L
      X1(1L)=X1L+XXC $ Y1(1L)=Y1L+YYC
      X2(1L)=X2L+XXC $ Y2(1L)=Y2L+YYC
      E(1L)=EE*EE/(XD*XD+YD*YD) $ L=L+1 $ GO TO 100
      120 READ 1,M1,X1L,Y1L,X2L,Y2L,VV,IF,LL
      IF (M1.GT.8) GO TO 170 $ NCD=NCD+1
      130 VL=VV*LL*0.01 $ SVL=SVL+VL $ EE=EFAC(IF)*VL
      XD=X2L-X1L $ YD=Y2L-Y1L
      DD=XD*XD+YD*YD $ X1L=X1L+XXC $ Y1L=Y1L+YYC
C
C THE MAIN LINK DATA ALSO USED TO COMPUTE EMISSION VALUES AT GRID POINTS
C
      1 VALUES STORED IN VCM, NO. OF GRID POINTS = NRW*NCL).
      ILZ=1+SQRT(DD)*DGS $ ZII=1.0/ILZ $ ZIL=EE*ZII
      YM=YD*ZQX*ZII $ XM=XD*ZQX*ZII
      YJ=Y1L*ZQX-YM*0.5+MRW $ XJ=X1L*ZQX-XM*0.5+MCL
      DO 135 I=1,ILZ
      YJ=YJ+YM $ XJ=XJ+XM $ JY=INT(YJ) $ JX=INT(XJ)
      IF (JY.LT.1.OR.JY.GE.NRW) GO TO 135
      IF (JX.LT.1.OR.JX.GE.NCL) GO TO 135
      DY=YJ-JY $ DX=XJ-JX $ IXY=(JX-1)*NRW+JY
      DY1=1.0-DY $ DX1=1.0-DX $ IXY1=IXY+1 $ IN=IXY+NRW $ IN1=IN+1
      VCM(IXY)=ZIL*DY1*DX1+VCM(IXY) $ VCM(IXY1)=ZIL*DY*DX1+VCM(IXY1)
      VCM(IN)=ZIL*DY1*DX+VCM(IN) $ VCM(IN1)=ZIL*DY*DX+VCM(IN1)
      135 CONTINUE

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      IL=(LL/25)+2 & ILM1=IL-1 & XDD=XD/ILM1 & YDD=YD/ILM1
      IF (NPT.EQ.1) 142,141
140  IF (NCD1.EQ.NCD) NOCD(1)=L
141  E(L)=EE*EE/DD & X1(L)=X1L & Y1(L)=Y1L & IFK(L)=IF
      X2(L)=X2L+XXC      & Y2(L)=Y2L+YVC      & L=L+1 & GO TO 120
142  XTL=X1L-XG & YTL=Y1L-YG
      DO 160 I=1,IL
      IF ((XTL*XTL+YTL*YTL).LT.CRAD2) GO TO 140
150  XTL=XTL+XDD
160  YTL=YTL+YDD & GO TO 120
170  NN=L-1 & IZS=CON=0.0
      PRINT 3,NN
C
C READS IN LOCAL EMISSION DATA AND TRANSFORMES IT ONTO A GRID
C (GRID VALUES STORED IN ARRAY VCL).
250  READ 2,M1,IX,IY,IZ
      IF (M1.GT.8) GO TO 275
      IZS=IZS+IZ
      CX=(IX+XXC)*0.01 & CY=(IY+YVC)*0.01
      YJ=CY*RG5+NRW & XJ=CX*RG5+NCL & JY=INT(YJ) & JX=INT(XJ)
      IF (JY.LT.1.OR.JY.GE.NRW) GO TO 270
      IF (JX.LT.1.OR.JX.GE.NCL) GO TO 270
      IXY=(JX-1)*NRW+JY & IXY1=IXY+1 & IXYN=IXY+NRW & IXYD=IXY+DX
      IXYN1=IXYN+1 & VCL(IXY)=IZ +VCL(IXY) & VCL(IXY1)=IZ +VCL(IXY1)
      VCL(IXYN)=IZ +VCL(IXYN) & VCL(IXYN1)=IZ +VCL(IXYN1)
270  CONTINUE
      GO TO 250
275  IZS=IZS*4 & IF (IZS.EQ.0) GO TO 280
      CON=0.01*CLE*SVL*ARI*EFAC(5)/IZS
280  DO 290 L=1,LT
      VCM(L)=ARI*VCM(L)
290  VCL(L)=CON*VCL(L)
      RETURN & END

```

```

      SUBROUTINE STORE
C
C THIS SUBROUTINE COMPUTES AND STORES X/Q AND Q VALUES (IF ITYP EQ 2).
C
      COMMON/CPTS/ NPT,XPT(625),YPT(625)
      COMMON/CSAV/ JS,L7,I9,K36,HMI, SXOQ(320),SQ12(3240),SQ34(3240),
      SQL(3240)
      COMMON /QUE/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),XOQ(10)
      JS=58 L7=78 I9=98 K36=368 HMI=37.5
      DO 100 J=1,JS JBS=(J-1)*L7+I98 HM=HMI
      DO 100 L=1,L78 LBS=(L-1)*I9+JBS8 HM=HM+HM
      CALL CALXOQ(HM,J)
      DO 100 I=1,I98 IBS=I+LBS
100  SXOQ(IBS)=XOQ(I)
      DO 200 N=1,NPT8 NBS=(N-1)*K36+I9
      DO 200 K=1,K368 KBS=(K-1)*I9+NBS8 KDR=K*10
      CALL CALQUE(KDR,N)
      DO 200 I=1,I98 IBS=I+KBS
      SQ12(IBS)=Q12(I) SQ34(IBS)=Q34(I)
200  SQL(IBS)=QL(I)
      RETURN8 END

```

```

C      SUBROUTINE RAOBHMM
C
C      THIS SUBROUTINE READS IN A HEADER CARD AND A RAOB SOUNDING
C      AND THE MAX AND MIN VALUES OF THE MIXING DEPTH ARE CALCULATED.
C
      DIMENSION THETA(25)
      COMMON /MIX/ ISTA,IYR,IMD,IDA,DAY,IDS,IMD,IST,IDATE,IDATE1,IDATE9
      COMMON /HMM/POP4,P(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
      1  FORMAT (/,1H,*,HMIN DENOM IS ZERO*)
      5  FORMAT(1A10,1110,315)
      6  FORMAT (22X,1F4.1,13X,1F5.1)
C
C      READ IN HEADER CARD AND RAOB DATA.
      READ 5,ISTA,IDAT,MAXT,MINT,IDSC
      IDS=IDS+IDSC$ IDATE1=IDAT
      IYR= IDAT*0.0001$ JMD= IDAT-IYR*10000$ IMD=JMD*0.01
      IDA=JMD-IMD*100$ DAY=30.5*(IMD-1)+IDA
      MAXT=(MAXT-32.0)*0.5555+273.7$ MINT=(MINT-32.0)*0.5555+273.7
      DO 25 L=1,100
      25 READ 6,T(L),P(L)$ T(L)=T(L)+273.2$ IF (P(L).EQ.500.0) GO TO 27
      27 NSL=L
C
C      DETERMINE THE PRESSURE LEVEL AT WHICH THE POTENTIAL TEMPERATURE
C      (THETA) IS GREATER THAN OR EQUAL TO THE SFC MAX POTENTIAL TEMPERATURE.
      60 IF (FLOAT(MAXT).LE.T(1)) 70,80
      70 HMAX=0.0 $ GO TO 120
      80 TETMX=((1000.0/P(1))*0.286)*MAXT
      DO 105 I=1,NSL
      THETA(I)=T(I)*((1000.0/P(I))*0.286
      100 IF (THETA(I).LT.TETMX) 105,100
      105 IS=I $ GO TO 110
      105 CONTINUE
      GO TO 115
C
C      CALCULATION OF MAX MIXING DEPTH.
      110 IS1=IS-1
      PM=P(IS1)*(P(IS)-P(IS1))*(TETMX-THETA(IS1))/(THETA(IS)-THETA(IS1))
      HMAX=14.7*(MAXT+T(IS1))*ALOG(P(1)/PM)
      IF (HMAX.GT.4000.0) 115,120
      115 HMAX=4000.0
      120 TOP=(T(2)-T(1))/(P(2)-P(1))
      DEN=0.5*TOP*(P(2)+P(1))-0.143*(T(2)+T(1))
      IF (DEN.NE.0.0) GO TO 130$ PRINT 1$ STOP
C
C      CALCULATION OF MIN MIXING DEPTH.
      130 HMIN=-14.7*(T(2)+T(1))*((10.0633-0.298*TOP)/DEN)*POP4
      IF (HMIN.LT.0.0) GO TO 135
      IF (HMIN.GT.4000.0) 135,140
      135 HMIN=4000.0
      140 IF (HMAX.LT.HMIN) HMAX=HMIN
      RETURN $ END

```

```

C      SUBROUTINE SFCOBS1
C
C      THIS SUBROUTINE READS IN THE FIRST SURFACE OBS CARD WHICH
C      CONSISTS OF THE 2400, 0100, 0200, AND 0300 HOURS OBS.
C
5      COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
      FORMAT (6X,I4,2I5,5X,I5,F5.0)
      READ 5,IHR(24),ICLD(24),ITEMP(24),IWD(24),WS(24)
      L=248 IHR(L)=L
      IWD(L)=10.0*IWD(L)$ WS(L)=0.5154*WS(L)
      ITEMP(L)=(ITEMP(L)-32.0)*0.55555+273.2
      RETURN $ END

```

```

C      SUBROUTINE SFCOBS2
C      THIS SUBROUTINE READS IN THE REST OF THE SURFACE OBSERVATIONS
C      FOR THE DAY.
C
COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
5  FORMAT (6X,14,2I5,5X,15,F5.0)
   READ 5,(IHR(L),ICLD(L),ITEMP(L),IWD(L),WS(L),L=1,23)
   DO 150 L=1,23
     IWD(L)=10.0*IWD(L)$ WS(L)=0.5154*WS(L)
150  ITEMP(L)=(ITEMP(L)-32.0)*0.55555+273.2
   RETURN $ END

```

```

C      SUBROUTINE EXTURB (EXTRAQ)
C
C      THIS SUBROUTINE DETERMINES THE MAX WIND SPEED FOR THE DAY AND
C      OBTAINS THE WIND DIRECTION VECTORIALLY. IT THEN CALCULATES THE
C      EXTRAURBAN CO CONTRIBUTION ON THE BASIS OF GASOLINE CONSUMPTION IN
C      THE SECTOR.
C
C      THE FUEL-ARRAY CONTAINS THE RATE OF GAS CONSUMPTION IN THE
C      SEGMENTS AS A FUNCTION OF WIND DIRECTION.
C
COMMON/CFUEL/      FUEL(16),NHOL(10)
COMMON /HMM/PUP4,P(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
1  FORMAT (/,1H ,*MAX WIND IS CALM.*)
C
C      DETERMINE THE 24-HOUR MAX WIND SPEED.
C      WSMAX=0.0
C      DO 100 I=1,24
C      IF (WS(I).GT.WSMAX) WSMAX=WS(I)
100  CONTINUE
C
C      DETERMINE THE COMPONENTS OF THE AVERAGE WIND DIRECTION FOR
C      THE MAX WIND SPEED.
C      NWD=XWS=YWS=0.0
C      DO 105 I=1,24
C      IF (WS(I).NE.WSMAX) GO TO 105
C      WDMAX=IWD(I)*0.0174533 $ NWD=NWD+1
C      XWS=XWS+SIN(WDMAX) $ YWS=YWS+COS(WDMAX)
105  CONTINUE
C
C      DETERMINE THE AVERAGE WIND DIRECTION ACCORDING TO 16 DIRECTIONAL
C      POINTS IN RADIAN.
C      IF (NWD.EQ.1) GO TO 135
C      IF (YWS.NE.0.0) GO TO 130
110  IF (XWS) 120,115,125
115  PRINT 1 $ STOP
120  WDMAX=4.7123889 $ GO TO 135
125  WDMAX=1.5707963 $ GO TO 135
130  WDMAX=ATAN(XWS/YWS)
C      IF (YWS.LT.0.0) WDMAX=WDMAX+3.1415927
C      IF (WDMAX.LT.0.0) WDMAX=WDMAX+6.2831853
135  DIR=2.5464791*WDMAX+0.5
C      IF (DIR.EQ.0) DIR=16
C
C      CALCULATE THE EXTRAURBAN CONCENTRATION.
C      EXTRAQ=(FUEL(DIR)*0.02900/(WSMAX*HMAX))+2.4E-4
C      RETURN $ END

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C      SUBROUTINE MINWIN (IT)
C
C      THIS SUBROUTINE CHECKS THE HOURLY WIND SPEED AND SETS EACH WIND
C      SPEED LESS THAN 1.0 M/S TO 1.0 ( FOR WIND SPEEDS EQUAL TO 0 THE
C      WIND DIRECTIONS ARE SET EQUAL TO THAT OF THE PREVIOUS HOUR).
C
COMMON /SFC/ IHR(24),ICHT(24),IND(24),WS(24),ICLD(24),ITEMP(24)
WI=WS(IT)
IF (WI.GE.1.0) GO TO 105
IF (WI.LE.0.0) IND(IT)=IDP& WS(IT)=1.0
105 IDP=IND(IT)
RETURN & END

```

```

C      SUBROUTINE STABLE(I,SAL,IJ)
C
C          THIS SUBROUTINE DETERMINES A STABILITY INDEX THROUGH A SERIES
C          OF CRITERIAS CONCERNING CLOUD COVER, WIND SPEED, AND SOLAR
C          ELEVATION (IJ=STABILITY INDEX).
C
C          DIMENSION IX(25),HCOS(25)
C          COMMON/CITY/ ITYP,ISM,IOUT(10)
C          COMMON/CSTAB/ SP180,CP180
C          COMMON /MIX/ ISTA,IYR,IMD,IDA,DAY,IDS,IMD,IST,IDATE,IDATE1,IDATE9
C          COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
C          COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
C          DATA (HCOS(L),L=1,24) /-0.9659,-0.866,-0.7071,-0.5,-0.2588,0.0,
1      0.2588,0.5,0.7071,0.866,0.9659,1.0,0.9659,0.866,0.7071,0.5,
2      0.2588,0.0,-0.2588,-0.5,-0.7071,-0.866,-0.9659,-1.0/
C          DATA(IX(L),L=1,15)/1,2,2,1,2,3,2,3,3,3,3,4,3,4,4/
C
C          CC=ICLD(I)*0.18 WSP=WS(I)*1.948 IJ=4
C
C          CALCULATION OF THE SIN OF THE SUNS ELEVATION ANGLE (SAL)
C          IF (ITYP.LT.3.AND.1.NE.1) GO TO 102
C          XT=-0.43378*COS(0.0172142*(10.0+DAY)) $ XS=XT/SQRT(1.0+XT*XT)
C          XC=XS/XT$ XSP=XS*SP180$ XCP=XC*CP180
C          IF (ITYP.LT.3) GO TO 102
C          I1=1-$ IF (1.LT.1) I=24$ SAP=XSP+HCOS(I1)*XCP
102 HC=HCOS(I)$ SAL=XSP+HC*XCP
C
C          IS IT OVERCAST (CC GE 0.9)
C          IF (CC.GE.0.9) GO TO 310
C
C          IS IT NIGHT (SAL LESS 0)
C          IF (SAL.LT.0.0) GO TO 305
C
C          CALCULATION OF DAYTIME STABILITY
C
C          IS THE SUN WITHIN 15 DEG OF HORIZON (SAL LESS 0.26)
C          IF (SAL.LT.0.26) GO TO 310
C
C          RADIATION AND CLOUD AMOUNT EFFECT (XSOL=INSULATION)
C          XSOL=(1.0-0.5*CC)*SAL
C          IF (XSOL.GT.0.30) GO TO 120
C          IRAD=3$ GO TO 200
120 IF (XSOL.GT.0.55) GO TO 130
C          IRAD=2$ GO TO 200
130 IRAD=1
C
C          WIND SPEED EFFECT
C
200 IF (WSP.GT.3.0) GO TO 210
C          IWS=1$ GO TO 300
210 IF (WSP.GT.6.0) GO TO 220
C          IWS=2$ GO TO 300
220 IF (WSP.GT.10.0) GO TO 230
C          IWS=3$ GO TO 300
230 IF (WSP.GT.12.0) GO TO 240
C          IWS=4$ GO TO 300
240 IWS=5
300 IEX=(IWS-1)*3+IRAD$ IJ=IX(IEX)$ GO TO 310

```

```

C
C      CALCULATION OF NIGHTTIME STABILITY
305 IF (WSP.GT.6.0) GO TO 310
    IF (CC.GE.0.5.AND.WSP.GT.3.0) GO TO 310
    IJ=5
310 IJS(I)=IJ
    RETURN$ END

```

```

C      SUBROUTINE DEPTH (IT,SAS,HT)
C
C      THIS SUBROUTINE CALCULATES THE ATMOSPHERIC MIXING DEPTH FOR EACH
C      HOUR. AT SUNSET, SUBROUTINES RAOBHMM AND SFCOBS1 ARE CALLED INITIATING
C      CALCULATIONS OF NIGHT-TIME MIXING DEPTHS.
C
      DIMENSION IWK(7)
      COMMON/CITY/ ITYP,ISH,IOUT(10)
      COMMON /DAY/ IDW,NH,IDAHO,IHW,IDWT
      COMMON /MIX/ ISTA,IYR,IMO,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,IDATE9
      COMMON /HMM/POP4,P(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
      COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
      COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
      DATA HSUN,HR SUN/1000.0,18.0/
      DATA (IWK(L),L=1,7) /5H(MON),5H(TUE),5H(WED),5H(THU),5H(FRI),
1    15H(SAT),5H(SUN)/,IHOL/5H(HOL)/
      FORMAT (/,1H,20X,          *DATE = *,          1X,16,2X,A5,4X,*NO. OF
1    1 RAOB LEVELS =*13,4X*SFC PRESS =*F7.1,4X*SFC MAX TEMP =*14,4X*SFC
      2MIN TEMP =*14,/)
      9    FORMAT(1H,63X,A10,/)
          ITT=ITEMP(IT)$ IF (ITT.LT.MINT) ITT=MINT
C
C      IS IT DAYTIME (SAS GREATER THAN 0).
C      IF (SAS.GT.0.0) GO TO 100
C
C      IS IT SUNSET
C      IF (SAP.GT.0.0) 105,120
C
C      LINEAR TEMPERATURE INTERPOLATION IS USED TO CALCULATE THE
C      DAYTIME MIXING DEPTH.
100    HT=HMIN+(ITT-MINT)*(HMAX-HMIN)/(MAXT-MINT) $ GO TO 132
105    HT=HMIN+(ITT-MINT)*(HMAX-HMIN)/(MAXT-MINT) $ HSUN=HT $ HRSUN=IT
C
C      AT SUNSET, PRINT THE BASIC STATION DATA, READ THE NEXT SOUNDING
C      AND CALCULATE THE MAX AND MIN MIXING DEPTHS, AND READ THE NEXT
C      DAYS FIRST FOUR HOURS OF SFC DATA.
108    IF (IOUT(1).LT.1) GO TO 115
          IF (ITIM.NE.1) PRINT 9,ISTA
          IF (IDAHO.EQ.0) GO TO 110
          PRINT 1,          IDATE1,IHOL,NSL,P(1),MAXT,MINT $ GO TO 115
110    PRINT 1,          IDATE1,IWK(IDW),NSL,P(1),MAXT,MINT
115    CALL RAOBHMM$ CALL SFCOBS1
          ITIM=1$ GO TO 135
C
C      TIME INTERPOLATION IS USED TO CALCULATE THE MIXING DEPTH
C      AFTER SUNSET.
120    IF (IT.GT.15) 125,130
125    HT=HMIN+(HSUN-HMIN)*(24-IT)/(24-HRSUN) $ GO TO 132
130    HT=HMIN
132    IF (ITYP.EQ.3) GO TO 108
135    IF (HT.LT.50) HT=50.0
          SAP=SAS
          HS(IT)=HT
          RETURN $ END

```

```

C      SUBROUTINE CALXQQ (HT,JI)
C
C      THIS SUBROUTINE CALCULATES THE X/Q VALUES FOR EACH OF THE
C      NINE SECTOR SEGMENTS USING THE GAUSSIAN AND BOX MODELS.
C
      DIMENSION      R(10),A(9,6),B(9,6),AA(54),BB(54)
      COMMON /QUE/  QL(10),QM(10),Q12(10),Q34(10),Q6(10),XQ(10)
      COMMON /ALLC/ YS(351),IYN(351)
      1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2YRC,XC2,BY2,BY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
      EQUIVALENCE (A,AA),(B,BB)
      DATA (R(I),I=1,10)/1.0,125.0,250.0,500.0,1000.0,2000.0,4000.0,
      18000.0,16000.0,32000.0/
C
C      VALUES USED FOR THE STABILITY PARAMETERS (A AND B).
      DATA(AA(L),L=1,54)/0.00,0.07,0.07,0.07,0.07,0.07,0.07,0.07,0.07,0.07,
      2 0.00,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,
      3 0.00,0.23,0.23,0.23,0.23,0.23,0.23,0.23,0.23,0.23,
      4 0.00,0.50,0.50,0.50,0.50,0.50,0.50,0.50,0.50,0.50,
      5 0.00,1.35,1.35,1.35,1.35,1.35,1.35,1.35,1.35,1.35,
      6 0.00,3.00,3.00,3.00,3.00,3.00,3.00,3.00,3.00,3.00/
      DATA(BB(L),L=1,54)/0.00,1.28,1.28,1.28,1.28,1.28,1.28,1.28,1.28,1.28,
      2 0.00,1.14,1.14,1.14,1.14,1.14,1.14,1.14,1.14,1.14,
      3 0.00,0.97,0.97,0.97,0.97,0.97,0.97,0.97,0.97,0.97,
      4 0.00,0.77,0.77,0.77,0.77,0.77,0.77,0.77,0.77,0.77,
      5 0.00,0.51,0.51,0.51,0.51,0.51,0.51,0.51,0.51,0.51,
      6 0.00,0.31,0.31,0.31,0.31,0.31,0.31,0.31,0.31,0.31/
      HP2R=0.797885*HT
      DO 140 I=1,9
      UP2R=0.797885/AR(I)$ UH=HT*AR(I)
      IP1=I+1 $ BIJ=B(I,JI) $ BIJ1=1.0-BIJ $ AIJ=A(I,JI)
      IF (I.GT.1) GO TO 25
      AIJ=A(2,JI)*R(2)*B(2,JI)$ GO TO 100
      25 RT=(HP2R/AIJ)**(1.0/BIJ)
      IF (R(IP1)-RT) 100,100,115
      100 IF (BIJ1) 110,105,110
      105 XQ(I)=(UP2R/AIJ)*ALOG(R(IP1)/R(I)) $ GO TO 140
      110 XQ(I)=(UP2R/(AIJ*BIJ1))*(R(IP1)**BIJ1-R(I)**BIJ1) $ GO TO 140
      115 IF (R(I)-RT) 125,125,120
      120 XQ(I)=(R(IP1)-R(I))/UH $ GO TO 140
      125 IF (BIJ1) 135,130,135
      130 XQ(I)=(UP2R/AIJ)*ALOG(RT/R(I))+(R(IP1)-RT)/UH $ GO TO 140
      135 XQ(I)=(UP2R/(AIJ*BIJ1))*(RT**BIJ1-R(I)**BIJ1)+(R(IP1)-RT)/UH
      140 CONTINUE
      RETURN $ END

```

```

      SUBROUTINE CALQUE (IWD,M)
C
C THIS SUBROUTINE COMPUTES THE CO EMISSION WITHIN EACH SECTOR SEGMENT.
C
      DIMENSION Y(20),X(20),IY(20),JY(20)
      COMMON/CITY/ IYTP,ISM,IOUT(10)
      COMMON/CPTS/ NPT,XPT(625),YPT(625)
      COMMON/CSTM/ VCAR(10),AST(10),WWST(10),ICST(10),NOCD(10)
      COMMON /QUE/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),XOQ(10)
      COMMON/CLODAT/IFK(1200),X1(1200),X2(1200),Y1(1200),Y2(1200),E(1200)
      COMMON /ALLC/ YS(351),IYN(351)
      1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2YRC,XC2,BY2,BY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
      XG=XPT(M)$ YG=YPT(M)
      MCD=NOCD(M)$ IF (ISM.EQ.0) MCD=0
      ANG=ACR*IWD $ CA=COS(ANG) $ SA=SIN(ANG)
      Y12=0.0625*YRC
      DO 210 I=1,9
      Q12(I)=Q34(I)=0.0
210  CONTINUE
C
C BEGINNING OF LOOP FOR COMPUTING EMISSION WITHIN EACH SECTOR SEGMENT.
      DO 300 NC=1,NN
      IF (MCD.EQ.NC) GO TO 300
C
C TRANSFORMATION OF COORDINATES.
221  XD1=X1(NC)-XG $YD1=Y1(NC)-YG $XD2=X2(NC)-XG $YD2=Y2(NC)-YG $IYT=0
      YS1=XD1*SA+YD1*CA$ YS2=XD2*SA+YD2*CA$ IF (YS1.LT.YS2) GO TO 216
      YSS=YS1$ YS1=YS2$ YS2=YSS $ IYT=1
216  IF (YS2.LT.0.OR.YS1.GT.YC1) GO TO 300
      JY(1)=JY(2)=0
      XS1=XD1*CA-YD1*SA$ XS2=XD2*CA-YD2*SA
      IF (IYT.EQ.0) GO TO 222
      XSS=XS1$ XS1=XS2$ XS2=XSS
C
C CHECK TO SEE IF LINK LIES WITHIN SECTOR.
222  B1=B2=BY2$ IF (YS1.GT.YC2) GO TO 224
      B1=BY1$ IF (YS2.LT.YC2) B2=BY1
224  IF (ABS(XS1).LT.B1*YS1) GO TO 230
      IF (ABS(XS2).LT.B2*YS2) GO TO 232
      IF (XS1*XS2.LT.0) GO TO 234
      IF (YS1.GT.YC2.OR.YS2.LT.YC2) GO TO 300
      IF (ABS(XS1).LT.XC2.OR.ABS(XS2).LT.XC2) 234,300
230  IF (ABS(XS2).LT.B2*YS2) JY(2)=1$ JY(1)=1$ GO TO 234
232  JY(2)=1
234  X(1)=XS1$ X(2)=XS2$ Y(1)=YS1$ Y(2)=YS2
      YD=YS1-YS2+0.0001 $ XD=XS1-XS2
      BL=XD/YD$ AL=XS1-BL*YS1
C
C LOCATES THE SEGMENT WITHIN WHICH THE END POINTS OF THE LINK LIE.
      IF (YS1.GT.0) GO TO 236
      Y(1)=YS1=0.0$ X(1)=XS1=AL
      IF (XS1.EQ.0) JY(1)=1
236  IY1=YS1*CRI+1 $ IY2=YS2*CRI+1
      IF (IY2.GT.350) IY2=350
      IY(1)=IYN(IY1)$ IF (YS1.GE.YS(IY1)) IY(1)=IY(1)+1
      IY(2)=IYN(IY2)$ IF (YS2.GE.YS(IY2)) IY(2)=IY(2)+1

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C
C LOCATES THE INTERSECTIONS OF LINK WITH SECTOR DIVIDING LINES.
N=2$ IF (IY(1).EQ.IY(2)) GO TO 250$ L=IY(1)
238 YP=YR(L)$ XP=AL+BL*YP$ IF (ABS(XP).GE.XR(L)) GO TO 240
N=N+1
X(N)=XP$ Y(N)=YP$ JY(N)=IY(N)=L
IF (L.EQ.LR4.AND.ABS(XP).GT.XRC) GO TO 240
N=N+1
X(N)=XP$ Y(N)=YP$ JY(N)=IY(N)=L+1
240 L=L+1$ IF (L.LT.IY(2)) GO TO 238
C
C LOCATES THE INTERSECTIONS OF LINK WITH SIDES OF SECTOR.
250 K=1
260 IF (ABS(X(K)).LT.8Y2*Y(K)) GO TO 280
SB=1.0$ IF (X(K).LT.0) SB=-1.0
B13=SB*B12$ XP=AL/(1.0-BL*B13)$ YP=B13*XP
IF (YP.LT.YRC.OR.YP.GT.YC1) GO TO 270
IYP=YP*CR1+1
N=N+1
IY(N)=IYN(IYP)$ IF (YP-YS(IYP)) 266,262,264
262 IF (K.EQ.1) 264,266
264 IY(N)=IY(N)+1
266 X(N)=XP$ Y(N)=YP$ JY(N)=IY(N)
270 IF (ABS(X(K)).LT.8Y1*Y(K)) GO TO 280
B13=SB*B11$ XP=AL/(1.0-BL*B13)$ YP=B13*XP
IF (YP.GT.YRC.OR.YP.LT.0) GO TO 280
IYP=YP*CR1+1
N=N+1
IY(N)=IYN(IYP)$ IF (YP-YS(IYP)) 276,272,274
272 IF (K.EQ.1) 274,276
274 IY(N)=IY(N)+1
276 X(N)=XP$ Y(N)=YP$ JY(N)=IY(N)
280 K=K+1$ IF (K.LT.3) GO TO 260
C
C COMPUTES EMISSION CONTRIBUTION OF LINK TO EACH SEGMENT
(RESULTS STORED IN Q).
C
DO 295 N1=1,N$ IF (JY(N1).EQ.0) GO TO 295$ NS1=IY(N1)
IF (NS1.GT.LRL) GO TO 294
NN1=N1+1
DO 292 N2= NN1,N$ IF (JY(N2).EQ.0) GO TO 292
NS2=IY(N2)$ IF (NS1.NE.NS2) GO TO 292
XDN=X(N1)-X(N2)$ YDN=Y(N1)-Y(N2)
QT=SQRT((XDN*XDN+YDN*YDN)*EINC)
350 IF (IFK(NC).LT.3) 285,286
285 Q12(NS1)=Q12(NS1)+QT $ GO TO 290
286 Q34(NS1)=Q34(NS1)+QT
290 JY(N2)=0.0 $ GO TO 294
292 CONTINUE
294 JY(N1)=0
295 CONTINUE
C
C END OF MAIN LOOP
300 CONTINUE
C
C COMPUTES CD EMISSION WITHIN SEGMENTS FROM MINOR LINK DATA.
CALL CALLOC(M)
RETURN $ END

```

SUBROUTINE CALLOC (N)

THIS SUBROUTINE USES THE GRID POINT VALUES (VCL AND VCM) TO COMPUTE THE AVERAGE CO EMISSIONS WITHIN EACH SECTOR SEGMENT. THE RESULTS ARE STORED IN QL AND QM.

```

COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON /QUE/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),XDQ(10)
COMMON /CLOQ/ VCL(2500),VCM(2500),CB(3),SB(3),NRW,NCL,MRW,MCL,CLC,
1GSP,RGS,ZQX
COMMON/ALLC/ YS(351),IYN(351)
1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
2YRC,XC2,BY2,BY1,BI2,BI1,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
XG=XPT(N)$ YG=YPT(N)
DO 30 L=1,9
YRL=YR(L)$ SEVL=SEVM=XDS=0.0$ KTN=LD=1
IF (L.LT.5) GO TO 5$ KTN=3$ LD=L-3
5 WCT=0.25/LD
DO 20 J=1,LD
FXDS=1.0-WCT*(1.0+2.0*(LD-J))$ YRR=YRL*FXDS$ SSEVM=SSEVL=0.0
DO 10 K=1,KTN
DIVI=YRR/CB(K)
YM=(DIVI*(CA*CB(K)-SA*SB(K))+YG)*ZQX+MRW
XM=(DIVI*(SA*CB(K)+CA*SB(K))+XG)*ZQX+MCL
IYM=INT(YM)$ IXM=INT(XM)
IF (IYM.LT.1.OR.IYM.GE.NRW) GO TO 10
IF (IXM.LT.1.OR.IXM.GE.NCL) GO TO 10
DYM=YM-IYM$ DXM=XM-IXM$ IXY=(IXM-1)*NRW+IYM
DYM1=1.0-DYM$ DXM1=1.0-DXM$ IXY1=IXY+1
TTEVL= (DYM1*VCL(IXY)+DYM*VCL(IXY1))*DXM1
1 +(DYM1*VCL(IXY+ NRW)+DYM*VCL(IXY1+NRW))*DXM
SSEVL=SSEVL+TTEVL
IF (L.LE.LRL) GO TO 10
TTEVM= (DYM1*VCM(IXY)+DYM*VCM(IXY1))*DXM1
2 +(DYM1*VCM(IXY+ NRW)+DYM*VCM(IXY1+NRW))*DXM
SSEVM=SSEVM+TTEVM
10 CONTINUE
SEVL=SEVL+SSEVL*FXDS$ SEVM=SEVM+SSEVM*FXDS$ XDS=XDS+FXDS*KTN
20 CONTINUE
QL(L)=SEVL*AR(L)/XDS
IF (L.GT.LRL) QL(L)=SEVM*AR(L)/XDS+QL(L)
30 CONTINUE
RETURN$ END

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      SUBROUTINE LOCXQ(HY,J)
C
C THIS SUBROUTINE LOCATES THE PROPER X/Q VALUES FROM STORAGE.
C
      COMMON/CSAV/ J5,L7,I9,K36,HMI,SXQ(1320),SQ12(13240),SQ34(13240),
1          SQL(13240)
      COMMON /QUE/ QL(10),QH(10),Q12(10),Q34(10),Q6(10),XQ(10)
      HB =HMI+HMI+HMI
      DO 10 L=1,L7$ IF (HT-LT-HB) GO TO 12
10 HB=HB+HB
12 IF (L.GT.L7) L=L7
      LBS=(L-1)*19+(J-1)*L7*19
      DO 100 I=1,I9$ IBS=I+LBS
100 XQ(I)=SXQ(IBS)
      RETURN$ END

```

```

      SUBROUTINE LOCQUE(KD,N)
C
C THIS SUBROUTINE LOCATES THE PROPER Q VALUES FROM STORAGE.
C
      COMMON/CSAV/ J5,L7,I9,K36,HMI,SXQU(320),SQ12(3240),SQ34(3240),
1      SQL(3240)
      COMMON /JUE/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),XDU(10)
      K=0.1*KD+0.56 IF (K.LT.1) K=K36$ KBS=(K-1)*19+(N-1)*K36+19
      DO 100 I=1,19$ IBS=I+KBS
      Q12(I)=SQ12(IBS)$ Q34(I)=SQ34(IBS)
100  QL(I)=SQL(IBS)
      RETURN$ END

```

```

C      SUBROUTINE CALCON (I,N,MT,EXTRAQ)
C
C      THIS SUBROUTINE COMPUTES THE CO CONCENTRATION AT THE
C      RECEPTOR POINT BASED ON THE VARIOUS MODELS. THE DIURNAL TRAFFIC
C      PATTERNS FOR WEEKDAYS, SATURDAYS, SUNDAYS, AND HOLIDAYS ARE INCLUDED
C      IN THE CO CALCULATIONS.
C
COMMON/CITY/ ITYP,ISM,IOUT(10)
COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON /DAY/ IDW,NH,IDAHD,IHW,IDWT
COMMON /MIX/ ISTA,IYR,IMO,IDA,DAY,IDS,IMD,IST,IDATE,IDATE1,IDATE9
COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
COMMON /SFC/ IHR(24),ICHT(24),IMD(24),WS(24),ICLD(24),ITEMP(24)
COMMON /CAR/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
COMMON /QUE/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),XQ(10)
COMMON /ALLC/ YS(351),IYN(351)
1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LRS,LR9,LR10,AG,YC1,YC2,XAC,
2,YRC,XC2,BY2,BY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
COMMON/CN24/ N24
IT=1
IF (N.EQ.1) IC=IC+1
10 CPL=0.08 WS175=0.75/(223.6932*WS(IT))
IDWT=IDWS IF (IDAHD.EQ.0) GO TO 158 IDWT=7
15 DO 120 J=1,9
ITT=IT-IFIX(IYR(J)*WS175)+IDS
IF (ITT.LT.1) ITT=ITT+246 IF (ITT.GT.24) ITT=1
IF (IDWT=6) 100,105,110
C
C      WEEKDAY CONCENTRATION CALCULATIONS.
100 FACT = Q12(J)*PT12(ITT)+(Q34(J) *QL(J))*PT34(ITT)
GO TO 120
C
C      SATURDAY CONCENTRATION CALCULATIONS.
105 FACT = PTSAT(ITT)*(Q12(J)+Q34(J) *QL(J)) GO TO 120
C
C      SUNDAY AND HOLIDAY CONCENTRATION CALCULATIONS.
110 FACT = PTSUN(ITT)*(Q12(J)+Q34(J) *QL(J))
120 CPL=CPL+FACT*XQ(J) CPL=CPL/WS(IT)
ID=NB IF (ITYP.LT.3) ID=IT+(N-1)*N24
CCAL(ID)=(CPL+EXTRAQ)*1000.0
RETURN & END

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```

      SUBROUTINE STREET(I,N)
C
C THIS SUBROUTINE COMPUTES THE STREET PROFILE OF CO CONCENTRATIONS BASED
C ON THE BACKGROUND VALUES, THE STREET EMISSION VALUES, AND THE
C METEOROLOGICAL CONDITIONS (RESULTS ARE STORED IN ARRAY CCAL).
C
      COMMON/CSTM/ VCAR(10),AST(10),WWST(10),ICST(10),NOC(10)
      COMMON /DAY/ IDW,NH,IDAHO,IHW,IDWT
      COMMON /MIX/ ISTA,IYR,IMO,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,IDATE9
      COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
      COMMON /CAR/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
      COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
      COMMON /ALLC/ YS(351),IYN(351)
      1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2,YRC,XC2,BY2,BY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CK,LRL
      COMMON/CN24/ N24
      DATA Z1,Z2,X,XLO,CK/38.8,3.65,22.8,8.0,2.0,7.0/
      IF (ITIME.EQ.1) GO TO 10
      DAN=0.87*CK/1.609$ X2=X*X
      XL1=1.0/(SQRT(Z1*Z1+X2)+XLO)$ XL2=1.0/(SQRT(Z2*Z2+X2)+XLO)
      HZ1=(Z3-Z1)/Z3$ HZ2=(Z3-Z2)/Z3
10  ID=1+(N-1)*N24$ CBG=CCAL(ID)
      W=WWST(N)$ ICS=ICST(N)
      DUN=DAN*EFAC(ICS)$ DUNS=0.5*DUN$ W1=1.0/W
      ITT=1+IDS$ IF (ITT.GT.24) ITT=1
      IF (IDWT-6) 12,14,16
12  PT9=PT6(ITT)$ GO TO 18
14  PT9=PTSAT(ITT)$ GO TO 18
16  PT9=PTSUN(ITT)
18  CRS=VCAR(N)*PT9/(0.5*WS(1)+0.25)
      AWD=IWD(1)$ IF (AWD.LT.AST(N)) AWD=AWD+360.0$ ANG=AWD-AST(N)
      IF (ANG.GT.180.0) ANG=ANG-360.0$ AANG=ABS(ANG)
      IF (AANG.GT.90.0) AANG=180.0-AANG$ IF (AANG.GT.30.0) GO TO 25
      DBAS=DUNS*CRS
      CCAL(ID+240)=CCAL(ID+720)=DBAS*(XL1+W1)+CBG
      CCAL(ID+480)=CCAL(ID+960)=DBAS*(XL2+W1)+CBG
      GO TO 50
25  DBAS=DUN*CRS$ 12=240$ 14=720$ IF (ANG.LT.0.0) GO TO 30
      12=720$ 14=240
30  IJ=12+240$ 15=14+240
      CCAL(ID+12)=DBAS*XL1+CBG$ CCAL(ID+13)=DBAS*XL2+CBG
      CCAL(ID+14)=DBAS*W1*HZ1+CBG$ CCAL(ID+15)=DBAS*W1*HZ2+CBG
50  ITIME=1
      RETURN$ END

```

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```

      SUBROUTINE PPDATA
C
C THIS SUBROUTINE PRINTS AND PUNCHES OUT THE STATION ID, DATE, MAX-MIN
C TEMPERATURES, ALL SFC DATA, STABILITY INDEX, MIXING DEPTH, AND THE
C CALCULATED CO CONCENTRATIONS.
C
      DIMENSION IDV(14)
      COMMON/CITY/ ITYP,ISM,IOUT(10)
      COMMON/CPTS/ NPT,XPT(625),YPT(625)
      COMMON /DAY/ IDW,NH,IDAHD,IHW,IDWT
      COMMON /MIX/ ISTA,IYR,IMO,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,IDATE9
      COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
      COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
      COMMON/CN24/ N24
      DATA (IDV(L),L=1,14)/10H HOUR =,10H CLD-M =,10H CLD-C =,
      110H TEMP =,10H WND-D =,10H WND-S =,10H STB-I =,10H MIX-
      2D =,10H CO-BG =,10H CO-R1 =,10H CO-R2 =,10H CO-L1 =,
      310H CO-L2 =,6H STA/
      1  FORMAT (1H ,5X,A10,24I5)
      2  FORMAT (1H ,5X,A10,24F5.0)
      3  FORMAT (1H ,5X,A10,24F5.1)
      4  FORMAT (1H ,5X,A10,24F5.2)
      5  FORMAT (/,1H ,*CO COMPUTATION TIME = *F6.3,* SEC.*/)
      6  FORMAT (A10,I10,4I4,F4.0,I4,F5.0,5F6.2)
      7  FORMAT(A10,I10,3I4,F4.0,I4,F5.0)
      8  FORMAT (1H ,5X,A6,I6)
      10  FORMAT(* CITY DATE HR PT CLD DIR SPD SI MD CBG
      ICR1 CR2 CL1 CL2*)
      11  FORMAT(* CITY DATE HR CLD DIR SPD SI MD*)
      12  FORMAT(8(14,F6.2))
C
C LIST OUT OUTPUT DATA IF IOUT(1) GT ZERO.
      IF (IOUT(1).LT.1) GO TO 100
      PRINT 1,IDV(1), (IHR(L),L=1,24)
      PRINT 1,IDV(3), (ICLD(L),L=1,24)
      PRINT 1,IDV(4), (ITEMP(L),L=1,24)
      PRINT 1,IDV(5), (IWD(L),L=1,24)
      PRINT 3,IDV(6), (WS(L),L=1,24)
      PRINT 1,IDV(7),(IJS(L),L=1,24)
      PRINT 2,IDV(8),(HS(L),L=1,24)
      NCE=58 IF (ISM.EQ.0) NCE=1
      DO 15 N=1,NPT$ ICB=(N-1)*N24
      PRINT 8,IDV(14),N
      IC1=ICB+1$ IC2=ICB+N24
      DO 15 NCB=1,NCE$ N9=8+NCB
      PRINT 4,IDV(N9),(CCAL(L),L=IC1,IC2)
      IC1=IC1+240$ IC2=IC2+240
      15 CONTINUE
C
C PUNCH OUT OUTPUT DATA IF IOUT(2) GT ZERO.
      100 IF (IOUT(2).LT.1) GO TO 200
      IF (ITYP.GT.2) GO TO 150
      IF (ITIM.NE.1) PUNCH 10
      DO 105 I=1,24$ DO 105 N=1,NPT$ ICB=(N-1)*N24+1
      105 PUNCH 6,ISTA,IDATE,1,N,ICLD(I),IWD(I),WS(I),IJS(I),HS(I),
      1 CCAL(ICB),CCAL(ICB+240),CCAL(ICB+480),CCAL(ICB+720),CCAL(ICB+960)
      GO TO 200

```

```

150 I=IHD
    IF (ITIM.NE.1) PUNCH 11
    PUNCH 7,ISTA,IDATE,I,ICLD(I),IND(I),WS(I),IJS(I),MS(I)
    PUNCH 12,(N,CCAL(N),N=1,NPT)
200 IF (IOUT(3).LT.1) GO TO 300
    IF (ITYP.GT.2) GO TO 250
    DO 205 I=1,248 DO 205 N=1,NPT$ ICB=(N-1)*N24+I
205 WRITE (41)
    1   ISTA,IDATE,I,N,ICLD(I),IND(I),WS(I),IJS(I),MS(I),
    2   CCAL(ICB),CCAL(ICB+240),CCAL(ICB+480),CCAL(ICB+720),CCAL(ICB+960)
    GO TO 300
250 I=IHD
    WRITE (41)
    1   ISTA,IDATE,I,ICLD(I),IND(I),WS(I),IJS(I),MS(I)
    2   ,(N,CCAL(N),N=1,NPT)
300 IHW=IHW+24
    ITIM=1
    IDATE=IDATE1
    RETURN $ END

```

Appendix B

EPA IBM 360/50 VERSION OF APRAC-1A COMPUTER PROGRAM

```

C      AIR POLLUTION DIFFUSION MODEL
C      THIS PROGRAM COMPUTES THE CO CONCENTRATIONS AT VARIOUS CITY
C      LOCATIONS BASED ON TRAFFIC AND METEOROLOGICAL INPUT DATA.
C
C      SET ITYPE EQUAL TO
C          1 FOR SYNOPTIC MODEL
C          2 FOR CLIMATOLOGICAL MODEL
C          3 FOR GRID PT MODEL.
C
C      REAL MRW,MCL
C      COMMON/CITY/ ITP,ISM,IOUT(10)
C      COMMON/CPIS/ NPT,XPT(625),YPT(625)
C      COMMON/CSTM/ VCAR(10),AST(10),MWST(10),ICST(10),NOC(10)
C      COMMON/CHANG/ HANG,ACV
C      COMMON /CORD/ XXC,YYC
C      COMMON /DAY/ IDW,NH,IDAHO,IHW,IDWT
C      COMMON/CSTAB/ SP180,CP180
C      COMMON/CFUEL/ FUEL(16),NHOL(10)
C      COMMON/CPFC/ PF1,PF2,PO1,PO2,S(9),KT(24)
C      COMMON/MIX/ISTA(10),IYR,IMD,IDA,DAY,IDS,IMD,IST,IDATE,IDATE1,
C      X IDATE9
C      COMMON /HMM/POP4,I(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
C      COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
C      COMMON /CAR/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
C      COMMON /QUE/ CL(10),QM(10),Q12(10),Q34(10),Q6(10),XQ(10)
C      COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
C      COMMON/CSAV/ J5,L7,I9,K36,HM1,SXQ(320),SQ12(3240),SQ34(3240),
C      SQL(3240)
C      COMMON /CLOQ/ VCL(2500),VCH(2500),CB(3),SB(3),NRW,NCL,MRW,MCL,CLE,
C      IGSP,RGS,ZOX
C      COMMON/CLDAT/IFK(1200),X1(1200),X2(1200),Y1(1200),Y2(1200),E(1200)
C      COMMON /ALLC/ YS(351),IYN(351)
C      1,XR(10),YP(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
C      2YRC,XC2,BY2,BY1,RI2,BI1,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
C      1 FORMAT (1H1,55X,'SYNOPTIC AIR POLLUTION MODEL'//)
C      2 FORMAT(1H1,52X,'CLIMATOLOGICAL AIR POLLUTION MODEL'//)
C      3 FORMAT (1H1,53X,'GRID POINT AIR POLLUTION MODEL'//)
C
C      INPUT THE BASIC PARAMETERS.
C      IHW=0
C      CALL INCAT
C      IF(IABS(ITYP).EQ.1)PRINT 1
C      IF(IABS(ITYP).EQ.2)PRINT 2
C      IF(IABS(ITYP).EQ.3)PRINT 3
C
C      COMPUTE THE EMISSION FACTOR AND OTHER INITIAL QUANTITIES.
C      CALL BASIC
C
C      INPUT THE MAJOR AND MINOR TRAFFIC EMISSION DATA.
C      CALL LINKS
C
C      PRECOMPUTE AND STORE ALL THE X/Q AND Q VALUES (IF ITYPE = 2).
C      IF(IABS(ITYP).EQ.2)CALL STORE
C
C      INPUT THE HEADER CARD AND RAOB OBSERVATIONS AND
C      DETERMINE THE MIN-MAX MIXING DEPTH FOR THE FIRST DAY.
C      CALL RAOBHM

```

```

C      INPUT THE FIRST SFC OBS CARD.
C      CALL SFCOBS1
C      INPUT THE REMAINING SFC OBS FOR THE DAY.
C      100 CALL SFCOBS2
C      DETERMINE THE EXTRAURBAN CO CONTRIBUTION.
C      CALL EXTURB (EXTRAQ)
C      BEGIN HOUR LOOP
C      DO 200 I=1,24
C      IN GRID POINT MODEL THE COMPUTATION IS DONE FOR HOUR IHD ONLY.
C      IF(IABS(ITYP).EQ.3) I=IHD
C      DETERMINE THE MINIMUM WIND SPED AND DIRECTION.
C      CALL MINWIN (I)
C      IWI=IWD(I)
C      DETERMINE THE STABILITY INDEX.
C      CALL STABLE(I,SAS,IJ)
C      DETERMINE THE MIXING DEPTH AND AT SUNSET INPUT THE HEADER
C      CARD, THE RACB DATA, AND THE FIRST FOUR HOURS OF SFC DATA
C      FOR THE NEXT DAY.
C      CALL CPPTH (I,SAS,HT)
C      DETERMINE THE X/Q VALUES USING THE GAUSSIAN AND BOX MODELS.
C      IF(IABS(ITYP).EQ.2) GO TO 140
C      GO TO 150
C      SELECTS APPROPRIATE X/Q VALUES FROM STORAGE.
C      140 CALL LOCXQ(HT,IJ)
C      GO TO 160
C      COMPUTE APPROPRIATE X/Q VALUES.
C      150 CALL CALXQ(HT,IJ)
C      BEGIN POINT LOOP
C      160 DO 190 N=1,NPT
C      DETERMINE THE Q VALUES FROM TRAFFIC EMISSION DATA.
C      IF(IABS(ITYP).EQ.2) GO TO 170
C      GO TO 180
C      SELECTS APPROPRIATE Q VALUES FROM STORAGE.
C      170 CALL LOCQF(IWI,N)
C      GO TO 189
C      COMPUTE APPROPRIATE Q VALUES.
C      180 IF(IABS(ITYP).EQ.3) IWI=IWD(IHD)
C      CALL CALQF(IWI,N)
C      DETERMINE THE TOTAL BACKGROUND CO CONCENTRATION.
C      189 CALL CALCON (I,N,HT,EXTRAQ)
C

```

```

C      DETERMINE THE STREET PROFILE CO CONCENTRATIONS IF ISM IS
C      NOT EQUAL TO ZERO.
      IF (ISM.NE.0) CALL STREET(I,N)
C
190  CONTINUE
      IF (IABS(IYP).EQ.3) GO TO 210
200  CONTINUE
210  CONTINUE
C
C      PRINT AND PUNCH THE DESIRED PARAMETERS.
      CALL PPDATA
C
C      DAY OF THE WEEK CHECK.
      IF (NH.EQ.0) GO TO 300
      IF (IDAH0.EC.0) GO TO 295
      IDAH0=0
      NH=NH-1
295  IF (IDATE1.EQ.NH01(NH)) IDAH0=1
300  ICW=IDW+1
      IF (IDW.LT.8) GO TO 400
      IDW=1
      IPW=1
      IC=0
C
C      CHECK FOR THE END OF THE TIME PERIOD.
400  IF (IDATE1.LE.IDATE9) GO TO 100
500  STOP
      END

```

SUBROUTINE INCAT

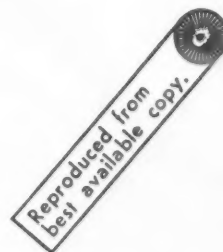
C
C
C
C

THIS SUBROUTINE READS IN BASIC DATA

```

REAL MRW,MCL
COMMON/CITY/ ITYP,ISM,IOUT(10)
COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON/CSTM/ VCAR(10),AST(10),WWST(10),ICST(10),NOCD(10)
COMMON /CCRD/ XXC,YYC
COMMON/CSTAB/ SP180,CPI80
COMMON /CAY/ IDW,NH,IDAHD,IHW,IDWT
COMMON/CPFC/ PF1,PF2,P01,P02,S(9),KT(24)
COMMON/CFUEL/ FUEL(16),NHOL(10)
COMMON/MIX/ISTA(10),IVP,IMO,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,
X IDATE9
COMMON /GRAF/ II(7),IA(24),IB(16,8),IV(5,8),IGS
COMMON /HMM/PCP4,P(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
COMMON /CAR/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
COMMON /PNT/ IC,PT2,IJS(24),HS(24),HR(168),CCAL(1200)
COMMON /CLOC/ VCL(2500),VCM(2500),CB(3),SB(3),NRW,NCL,MRW,MCL,CLE,
IGSP,SGS,ZQX
COMMON/CN24/ N24
1 FORMAT(8I10)
3 FORMAT(8F10.4)
4 FORMAT(5F10.4,2I10)
5 FORMAT(2F10.4)
6 FORMAT(F10.2,2I10)
IDS=0
READ 1,ITYP,ISM,NPT,(IOUT(I),I=1,5)
READ 6,IGSP,MRW,NCL
IF(IABS(ITYP).GT.2)GO TO 15
READ 4,(XPT(I),YPT(I),AST(I),VCAR(I),WWST(I),ICST(I),NOCD(I),
2 I=1,NPT)
GO TO 17
15 ISM=0
READ 5,(XPT(I),YPT(I),I=1,NPT)
17 READ 3,SLAT,P0PS,XXT,YYT,CLE,PF1,P01
READ 3,(FUEL(I),I=1,16)
READ 3,(S(I),I=1,8)
READ 1,(KT(I),I=1,24)
READ 3,(PT12(I),I=1,24)
READ 3,(PT34(I),I=1,24)
READ 3,(PT6(I),I=1,24)
READ 3,(PTSAT(I),I=1,24)
READ 3,(PTSUN(I),I=1,24)
READ 1,ICATF,IDATE9,IDW,IHD,NH
IF(NH.GT.C)READ 1,(NHCL(I),I=1,NH)
IF(IABS(ITYP).LT.2.AND.NPT.GT.10)NPT=10
N24=24
IF(IABS(ITYP).LT.3)GO TO 19
N24=1
ISM=0
19 GO 20 I=1,9
20 IF (S(I).LT.1.0) S(I)=99.0
XXC=-XXT
YYC=-YYT
DO 30 I=1,NPT

```



```

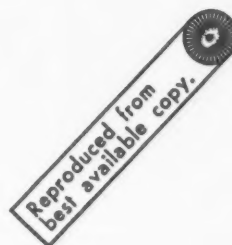
XPT(I)=XPT(I)+XXC
30 YPT(I)=YPT(I)+YYC
POPS=POPS*1.0F6
POP4=SQRT(SQRT(POPS))
IGS=IHW
IC=IHW-1
IDAHC=0
SAP=-1.0
ACR=0.0174523
PL180=ACR*SLAT
SP180=SIN(PL180)
CP180=COS(PL180)
PF1=PF1/3600.0
RETURN
END

```

```

C      SURROUTINE BASIC
C      THIS SUBROUTINE COMPUTES BASIC QUANTITIES USED THROUGHOUT PROGRAM
C
C      COMMON/CHANG/ HANG,ACV
C      COMMON/CPFC/ PF1,PF2,P01,P02,S(9),KT(24)
C      COMMON /CAR/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
C      COMMON /ALLC/ YS(351),IYN(351)
C      1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
C      2,YRC,XC2,BY2,BY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
C      ACR=0.0174533
C      CR=62.137
C      HANG=0.196349625
C      LRL=5
C
C      COMPUTES BASIC FACTORS FOR EMISSION MODEL
C      KT(I)=PEAK CR NON PEAK TRAFFIC AT ITH HOUR
C      PT(I)=FRACTION OF DAILY TRAFFIC DURING ITH HOUR
C      EFAC(I)=EMISSION FACTOR FOR ITH FACILITY TYPE
C      S(I)=SPEED FOR ITH FACILITY
C      P01 AND PF1=INPUT CONSTANTS.
C      TN1125=TAN(HANG)
C      RR=7.7671
C      CRI=10.0/CR
C      ACV=CRI*CRI*1.0E4
C      LR4=4
C      LR5=LR4+1
C      LR9=9
C      LR10=LR9+1
C      XP=0.85**P01
C      DO 50 I=1,24
C      IF (KT(I).EQ.1) GO TO 45
C      GO TO 50
C 45  PT12(I)=PT12(I)*XP
C      PT34(I)=PT34(I)*XP
C      PT6(I)=PT6(I)*XP
C 50  CONTINUE
C      DO 60 I=1,9
C 60  EFAC(I)= PF1*S(I)**P01
C
C      COMPUTES GEOMETRIC QUANTITIES FOR SECTOR SEGMENTS
C      AR(I)=AREA OF ITH SEGMENT
C      YR(I)=MAX DISTANCE OF ITH SEGMENT FROM RECEPTOR
C      XR(I)=MAX HALF WIDTH OF SEGMENT
C      LR4 AND LR9=NO. OF SEGMENTS IN SMALLER AND TOTAL SECTOR.
C      DO 210 L=1,LR10
C      AG=11.25
C      IF (L.LT.LR5) AG=22.5
C      AG=ACR*AG
C      TANAG=TAN(AG)
C      YR(L)=SQRT(RR*RR*AG/TANAG)
C      XR(L)=YR(L)*TANAG
C      IF(L.EQ.LR1)YC1=YR(L)
C      IF (L.NE.LR4) GO TO 210
C      YC2=YR(L)
C      XRC= YC2*TN1125
C      XC2=XR(L)
C      YRC=YC2

```



```

210 PR=PR+RR
    AR(1)=XR(1)*YR(1)*ACV
    SUMA=AR(1)
    DO 211 I=2,4
    AR(I)=XR(I)*YR(I)*ACV-SUMA
211 SUMA=SUMA+AR(I)
    SUMA=XRC*YR(4)*ACV
    DO 212 I=5,LR10
    AR(I)=XR(I)*YR(I)*ACV-SUMA
212 SUMA=SUMA+AR(I)
    RY2=      TN1125
    BY1=      TAN(ACR*22.5)
    RI2=1.0/BY2
    BI1=1.0/BY1
    L=L+1
    DO 213 K0=1,351
    K=K0-1
    K1=K+1
    IF (K.GT.YR(L)*CRI) L=L+1
    YS(K1)=YR(L)
    IYN(K1)=L
213 CONTINUE
    RETURN
    END

```

SUBROUTINE LINKS

C
C THIS SUBROUTINE READS IN DATA FOR MAIN AND LOCAL LINKS.
C

```

      REAL MRW,MCL
      DIMENSION V(8)
      COMMON/CITY/ITYP,ISM,ICUT(10)
      COMMON/CPTS/ NPT,XPT(625),YPT(625)
      COMMON/CSTM/ VCAR(10),AST(10),WHST(10),ICST(10),NOC(10)
      COMMON /CORP/ XXC,YXC
      COMMON/CHARG/ HANG,ACV
      COMMON/CLDAT/IFK(1200),X1(1200),X2(1200),Y1(1200),Y2(1200),E(1200)
      COMMON/ALLC/ YS(351),IYN(351)
      1,XR(10),YR(10),AR(10),FFAC(9),ACP,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2,YRC,XC2,BY2,BY1,R12,R11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
      COMMON /CLC/ VCL(2500),VCM(2500),CR(3),SB(3),NFW,NCL,MFW,MCL,CLE,
      IGSP,SGS,ZOX
      1   FORMAT(11,9X,4F5.0,F6.0,2I5)
      2   FORMAT(11,9X,3I10)
      3   FORMAT(11,9X,10, OF LINKS =',15,/)
      4   FORMAT(8F10.6)
      5   FORMAT(2X,'GRID INPUT, ',14,' X',14)
      IF(ITYP.GT.0)GO TO 60
      LT=MRW*NCL
      N=0
      15  READ 4,V
      DO 20 I=1,8
      N=N+1
      IF(N.GT.LT)GO TO 60
      20  VCM(N)=V(I)
      GO TO 15
      60  MRW=MRW*0.5
      MCL=NCL*0.5
      LT=MRW*NCL
      AR=1.0/(IGSP*CS*ACV)
      SGS=100.0/IGSP
      DGS=.05*SGS
      ZOX=0.01*SGS
      CRAD2=YC1*YC1/0.96+1000
      SVL=0.0
      NC)=0
      L=1
      A75=0.933*HANG
      IF(IARS(ITYP).EQ.3)GO TO 65
      NCD1=NOC(1)
      65  XG=XPT(1)
      YG=YPT(1)
      CR(1)=1.0
      CR(2)=COS(A75)
      CR(3)=COS(A75)
      SR(1)=0.0
      SR(2)=SIN(-A75)
      SR(3)=-SR(2)
      IF(ITYP.LT.0)GO TO 80
      DO 75 I=1,LT
      VCL(I)=0.
      75  VCM(I)=0.
      C
  
```

```

C READS IN DATA FOR MAIN LINKS
C (LINK DATA STORED IN ARRAYS X1,Y1,X2,Y2,AND E).
  IF (LRL.GE.LP9) GO TO 100
  GO TO 120
100 READ 1,M1,X1L,Y1L,X2L,Y2L,VV,IF,LL
  IF (M1.LT.9) GO TO 110
  GO TO 170
110 VL=VV*LL*0.01
  SVL=SVL+VL
  EE=EFAC(IF)*VL
  IFK(L)=IF
  XD=X1L-X2L
  YD=Y1L-Y2L
  X1(L)=X1L+XXC
  Y1(L)=Y1L+YYC
  X2(L)=X2L+XXC
  Y2(L)=Y2L+YYC
  E(L)=EE*EE/(XD*XD+YD*YD)
  L=L+1
  GO TO 100
120 READ 1,M1,X1L,Y1L,X2L,Y2L,VV,IF,LL
  IF (M1.GT.8) GO TO 170
  NCD=NCD+1
130 VL=VV*LL*0.01
  SVL=SVL+VL
  EE=EFAC(IF)*VL
  XD=X2L-X1L
  YD=Y2L-Y1L
  DD=XD*XD+YD*YD
  X1L=X1L+XXC
  Y1L=Y1L+YYC
C
C THE MAIN LINK DATA ALSO USED TO COMPUTE EMISSION VALUES AT GRID POINTS
C (VALUES STORED IN VCM, NO. OF GRID POINTS = NRW*NCCL).
  ILZ=1+SQRT(DD)*DGS
  Z11=1.0/ILZ
  Z1L=EE*Z11
  YM=YD*ZQX*Z11
  XM=XD*ZQX*Z11
  YJ=Y1L*ZQX-YM*0.5+NRW
  XJ=X1L*ZQX-XM*0.5+NCCL
  DO 135 I=1,ILZ
  YJ=YJ+YM
  XJ=XJ+XM
  JY=INT(YJ)
  JX=INT(XJ)
  IF (JY.LT.1.OR.JY.GE.NRW) GO TO 135
  IF (JX.LT.1.OR.JX.GE.NCCL) GO TO 135
  DY=YJ-JY
  DX=XJ-JX
  IX=(JX-1)*NRW+JY
  DY1=1.0-DY
  DX1=1.0-DX
  IXY1=IXY+1
  IN=IXY+NRW
  IN1=IN+1
  VCM(IXY)=Z1L*DY1*DX1*VCM(IXY)

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```

VCM(IXY1)=ZIL*DY*DX1+VCM(IXY1)
VCM(IN)=ZIL*DY1*DX+VCM(IN)
VCM(IN1)=ZIL*DY*DX+VCM(IN1)
135 CONTINUE
IL=(LL/25)+2
ILM1=IL-1
XCD=XD/ILM1
YDD=YD/ILM1
IF (NPT.EQ.1) GO TO 142
GO TO 141
140 IF (NCD1.EQ.NCD) NCD(1)=L
141 E(L)=EE*FE/DD
X1(L)=X1L
Y1(L)=Y1L
IFK(L)=IF
X2(L)=X2L+XXC
Y2(L)=Y2L+YYC
L=L+1
GO TO 120
142 XTL=X1L-XG
YTL=Y1L-YG
DO 160 I=1,IL
IF ((XTL*XTL+YTL*YTL).LT.CRAD2) GO TO 140
150 XTL=XTL+XCD
160 YTL=YTL+YDD
GO TO 120
170 NA=L-1
IZS=0.0
CCN=0.0
GO TO 175
80 PRINT 5,NRW,NCL
DO 90 I=1,LT
VCL(I)=VCL(I)*0.0
90 VCM(I)=VCM(I)*ARI
RETURN
175 PRINT 3,MN
C
C READS IN LOCAL EMISSION DATA AND TRANSFORMES IT ONTO A GRID
C (GRID VALUES STORED IN ARRAY VCL).
250 READ 2,M1,IX,IY,IZ
IF (M1.GT.8) GO TO 275
IZS=IZS+IZ
CX=(IX+XXC)*0.01
CY=(IY+YYC)*0.01
YJ=CY*RG5+NRW
XJ=CX*RG5+MCL
JY=INT(YJ)
JX=INT(XJ)
IF (JY.LT.1.OR.JY.GF.NRW) GO TO 270
IF (JX.LT.1.OR.JX.GE.NCL) GO TO 270
IXY=(JX-1)*NRW+JY
IXY1=IXY+1
IXYN=IXY+NRW
DYDX=DY*DX
IXYN1=IXYN+1
VCL(IXY)=IZ +VCL(IXY)
VCL(IXY1)=IZ +VCL(IXY1)

```

```

      VCL(I,XYN)=IZ  +VCL(I,XYN)
      VCL(I,XYN1)=IZ +VCL(I,XYN1)
270  CONTINUE
      GO TO 250
275  IZS=IZS*4
      IF (IZS.EQ.0) GO TO 280
      CON=0.01*CLE*SVL*ARI*EFAC(5)/IZS
280  DO 290 L=1,LT
      VCM(L)=ARI*VCM(L)
290  VCL(L)=CON*VCL(L)
      RETURN
      END

```

```

SUBROUTINE RAOBHM
C
C      THIS SUBROUTINE READS IN A HEADER CARD AND A RAOB SOUNDING
C      AND THE MAX AND MIN VALUES OF THE MIXING DEPTH ARE CALCULATED.
C
      DIMENSION THETA(25)
      COMMON/MIX/ISTA(10),IYR,IMD,IDA,DAY,IDS,IMD,IST,IDATE,IDATE1,
X IDATE9
      COMMON /HMP/POP4,P(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
1  FORMAT (1,1F,'HMIN DENCM IS ZERO')
5  FORMAT(10A,110,3I5)
6  FORMAT (22X,1F4.1,13X,1F5.1)
C
C      READ IN HEADER CARD AND RAOB DATA.
      READ 5, ISTA, ICAT, MAXT, MINT, IDSC
      IDS=IDS+IDSC
      IDATE1=ICAT
      IYR= ICAT*0.0001
      JMD= ICAT-IYR*10000
      IMD=JMD*0.01
      IDA=JMD-IMD*100
      DAY=30.5*(IMD-1)+IDA
      MAXT=(MAXT-32.0)*0.5555+273.7
      MINT=(MINT-32.0)*0.5555+273.7
      DO 25 L=1,100
      READ 6,T(L),P(L)
      T(L)=T(L)+273.2
      IF (P(L).EQ.500.0) GO TO 27
25  CONTINUE
27  NSL=L
C
C      DETERMINE THE PRESSURE LEVEL AT WHICH THE POTENTIAL TEMPERATURE
C      (THETA) IS GREATER THAN OR EQUAL TO THE SFC MAX POTENTIAL TEMPERATURE.
60  IF (FLOAT(MAXT).LE.T(1)) GO TO 70
      GO TO 80
70  HMAX=C.0
      GO TO 120
80  TETMX=((1000.0/P(1))*0.286)*MAXT
      DO 105 I=1,NSL
      THETA(I)=T(I)*((1000.0/P(I))*0.286)
      IF (THETA(I).LT.TETMX) GO TO 105
      GO TO 100
100  IS=I
      GO TO 110
105  CONTINUE
      GO TO 115
C
C      CALCULATION OF MAX MIXING DEPTH.
110  IS1=IS-1
      PM=P( IS1)*(P( IS)-P( IS1))*((TETMX-THETA( IS1))/(THETA( IS)-THETA( IS1)))
      HMAX=14.7*(MAXT+T( IS))*ALOG(P(1)/PM)
      IF (HMAX.GT.4000.0) GO TO 115
      GO TO 120
115  HMAX=4000.0
120  TOP=(T(2)-T(1))/(P(2)-P(1))
      DEN=0.5*TOP*(P(2)+P(1))-0.143*(T(2)+T(1))
      IF (DEN.NE.C.0) GO TO 130
      PRINT 1

```

```

      STOP
C
C  CALCULATION OF MIN MIXING DEPTH.
130  HMIN=-14.7*(T(2)+T(1))*((0.0633-0.298*TOP)/DEN)*POP4
      IF (HMIN.LT.0.0) GO TO 135
      IF (HMIN.GT.4000.0) GO TO 135
      GO TO 140
135  HMIN=4000.0
140  IF (HMAX.LT.HMIN) HMAX=HMIN
      RETURN
      END

```

SUBROUTINE STORE

C THIS SUBROUTINE COMPUTES AND STORES X/Q AND Q VALUES (IF ITYP EQ 2).
C
C

```

COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON/CSAV/ J5,L7,I9,K36,HMI,SXQ(320),SQ12(324),SQ34(3240),
1      SQL(3240)
COMMON /QUE/ CL(10),QM(10),Q12(10),Q34(10),Q6(10),XNQ(10)
J5=5
L7=7
I9=9
K36=36
HMI=37.5
DO 100 J=1,J5
JBS=(J-1)*L7*I9
HM=HMI
DO 100 L=1,L7
LBS=(L-1)*I9+JBS
HM=HM+HM
CALL CALXCQ(HM,J)
DO 100 I=1,I9
IBS=I+LBS
100 SXNQ(IBS)=XNQ(I)
DO 200 N=1,NPT
NBS=(N-1)*K36+I9
DO 200 K=1,K36
KBS=(K-1)*I9+NBS
KDR=K*10
CALL CALQUE(KDR,N)
DO 200 I=1,I9
IBS=I+KBS
SQ12(IBS)=Q12(I)
SQ34(IBS)=Q34(I)
200 SQL(IBS)=QL(I)
RETURN
END

```

```

SUBROUTINE SFC001
C
C      THIS SUBROUTINE READS IN THE FIRST SURFACE OBS CARD WHICH
C      CONSISTS OF THE 2400, 0100, 0200, AND 0300 HOURS OBS.
C
COMMON /SFC/ IHR(24), ICHT(24), IWD(24), WS(24), ICLD(24), ITFMP(24)
5  FORMAT (6X, I4, 2I5, 5X, I5, F5.0)
READ 5, IHR(24), ICLD(24), ITFMP(24), IWD(24), WS(24)
L=24
IHR(L)=L
IWD(L)=10.0*IWD(L)
WS(L)=0.5154*WS(L)
ITFMP(L)=(ITFMP(L)-32.0)*0.55555+273.2
RETURN
END

```

```

SUBROUTINE SFCOR2
C
C      THIS SUBROUTINE READS IN THE REST OF THE SURFACE OBSERVATIONS
C      FOR THE DAY.
C
COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
5  FORMAT (6X,14,2I5,5X,15,F5.0)
   READ 5,(IHR(L),ICLD(L),ITEMP(L),IWD(L),WS(L),L=1,73)
   DO 150 L=1,23
     IWD(L)=10.0*IWD(L)
     WS(L)=0.5154*WS(L)
150  ITEMP(L)=(ITEMP(L)-32.0)*0.55555+273.2
   DO 40 I=1,1200
40  CCAL(I)=0.0
   RETURN
   END

```

```

SUBROUTINE EXTURB (EXTRAQ)
C
C      THIS SUBROUTINE DETERMINES THE MAX WIND SPEED FOR THE DAY AND
C      OBTAINS THE WIND DIRECTION VECTORIALLY. IT THEN CALCULATES THE
C      EXTRAURBAN CO CONTRIBUTION ON THE BASIS OF GASOLINE CONSUMPTION IN
C      THE SECTOR.
C
C      THE FUEL-ARRAY CONTAINS THE RATE OF GAS CONSUMPTION IN THE
C      SEGMENTS AS A FUNCTION OF WIND DIRECTION.
C
COMMON /CFUEL/ FUEL(16),NHOL(10)
COMMON /HMM/POP4,P(25),T(25),MAXT(12),HMAX,HMIN,NSL,SAP
COMMON /SFC/ IHR(24),ICHT(24),IWD(5),WS(24),ICLD(24),ITEMP(24)
1  FORMAT (/,1H,'MAX WIND IS CALM.')
```

C
C DETERMINE THE 24-HOUR MAX WIND SPEED.
WSMAX=0.0
DO 100 I=1,24
IF(WS(I).GT.WSMAX)WSMAX=WS(I)
100 CONTINUE

C
C DETERMINE THE COMPONENTS OF THE AVERAGE WIND DIRECTION FOR
C THE MAX WIND SPEED.
NWD=0.0
XWS=0.0
YWS=0.0
DO 105 I=1,24
IF (WS(I).NE.WSMAX) GO TO 105
WDMAX=IWD(I)*0.0174533
NWD=NWD+1
XWS=XWS+SIN(WDMAX)
YWS=YWS+COS(WDMAX)
105 CONTINUE

C
C DETERMINE THE AVERAGE WIND DIRECTION ACCORDING TO 16 DIRECTIONAL
C POINTS IN RADIANS.
IF (NWD.EQ.1) GO TO 135
IF (YWS.NE.0.0) GO TO 130
110 IF (XWS) 120,115,125
115 PRINT 1
STOP
120 WDMAX=4.7123889
GO TO 135
125 WDMAX=1.5707963
GO TO 135
130 WDMAX=ATAN(XWS/YWS)
IF (YWS.LT.0.0) WDMAX=WDMAX+3.1415927
IF (WDMAX.LT.0.0) WDMAX=WDMAX+6.2831853
135 IDIR=2.5464791*WDMAX+0.5
IF (IDIR.EQ.0) IDIR=16

C
C CALCULATE THE EXTRAURBAN CONCENTRATION.
EXTRAQ=(FUEL(IDIR)*0.02900/(WSMAX*HMAX))+2.4E-4
RETURN
END

SUBROUTINE MINWIN (IT)

C
C THIS SUBROUTINE CHECKS THE HOURLY WIND SPEED AND SETS EACH WIND
C SPEED LESS THAN 1.0 M/S TO 1.0 (FOR WIND SPEEDS EQUAL TO 0 THE
C WIND DIRECTIONS ARE SET EQUAL TO THAT OF THE PREVIOUS HOUR).
C

COMMON /SFC/ IHR(24), ICHT(24), IWD(24), WS(24), ICLD(24), ITEMP(24)

DATA IDP/270/

WT=WS(IT)

IF (WT.GE.1.0) GO TO 105

IF (WT.LE.0.0) IWD(IT)=IDP

WS(IT)=1.0

105 IDP=IWD(IT)

RETURN

END

```

C      SUBROUTINE STABLE(I,SAL,IJ)
C
C      THIS SUBROUTINE DETERMINES A STABILITY INDEX THROUGH A SERIES
C      OF CRITERIAS CONCERNING CLOUD COVER, WIND SPEED, AND SOLAR
C      ELEVATION (IJ=STABILITY INDEX).
C
C      DIMENSION IX(25),HCOS(25)
C      COMMON/CITY/ ITYP,ISM,IOUT(10)
C      COMMON/CSTAB/ SP180,CP180
C      COMMON/MIX/ISTA(10),IYR,IMD,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,
C      X IDATE9
C      COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
C      COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
C      DATA HCOS/-0.9659,-0.866,-0.7071,-0.5,-0.2588,0.0,
C      1 0.2588,0.5,0.7071,0.866,0.9659,1.0,0.9659,0.866,0.7071,0.5,
C      2 0.2588,0.0,-0.2588,-0.5,-0.7071,-0.866,-0.9659,-1.0,0.0/
C      DATA IX/1,2,2,1,2,3,2,3,3,3,3,4,3,4,4,4,10*0/
C
C      CC=ICLD(I)*0.1
C      WSP=WS(I)*1.94
C      IJ=4
C
C      CALCULATION OF THE SIN OF THE SUNS ELEVATION ANGLE (SAL)
C      IF(IABS(ITYP).LT.3.AND.I.NE.1)GO TO 102
C      XT=-0.43378*CCS(0.0172142*(10.0+DAY))
C      XS=XT/SQRT(1.0+XT*XT)
C      XC=XS/XT
C      XSP=XS*SP180
C      XCP=XC*CP180
C      IF(IABS(ITYP).LT.3)GO TO 102
C      I1=I-1
C      IF (I.LT.1) I=24
C      SAP=XSP+HCOS(I1)*XCP
C      102 HC=HCOS(I)
C      SAL=XSP+HC*XCP
C
C      IS IT CVERCAST (CC GE 0.9)
C      IF (CC.GE.0.9) GO TO 310
C
C      IS IT NIGHT (SAL LESS 0)
C      IF (SAL.LT.0.0) GO TO 305
C
C      CALCULATION OF DAYTIME STABILITY
C
C      IS THE SUN WITHIN 15 DEG OF HORIZON (SAL LESS 0.26)
C      IF (SAL.LT.0.26) GO TO 310
C
C      RADIATION AND CLOUD AMOUNT EFFECT (XSOL=INSULATION)
C      XSOL=(1.0-0.5*CC)*SAL
C      IF (XSOL.GT.0.30) GO TO 120
C      IRAD=3
C      GO TO 200
C      120 IF (XSOL.GT.0.55) GO TO 130
C      IRAD=2
C      GO TO 200
C      130 IRAD=1
C
C      WIND SPEED EFFECT

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```

200 IF (WSP.GT.3.0) GO TO 210
    IWS=1
    GO TO 300
210 IF (WSP.GT.6.0) GO TO 220
    IWS=2
    GO TO 300
220 IF (WSP.GT.10.0) GO TO 230
    IWS=3
    GO TO 300
230 IF (WSP.GT.12.0) GO TO 240
    IWS=4
    GO TO 300
240 IWS=5
300 IEX=(IWS-1)*3+IRAD
    IJ=IX(IEX)
    GO TO 310

C
C      CALCULATION OF NIGHTTIME STABILITY
305 IF (WSP.GT.6.0) GO TO 310
    IF (CC.GE.0.5.AND.WSP.GT.3.0) GO TO 310
    IJ=5
310 IJS(I)=IJ
    RETURN
    END

```

```

SUBROUTINE DEPTH (IT,SAS,HT)

C
C      THIS SUBROUTINE CALCULATES THE ATMOSPHERIC MIXING DEPTH FOR EACH
C      HOUR.  AT SUNSET, SUBROUTINES RAOBHMM AND SFCORS1 ARE CALLED INITIATING
C      CALCULATIONS OF NIGHT-TIME MIXING DEPTHS.
C

COMMON/CITY/ ITYP,ISM,IOUT(10)
COMMON /DAY/ IDW,NH,IDAHO,IHW,IDWT
COMMON/MIX/ ISTA(10),IYR,IMN,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,
X IDATE9
COMMON /HMM/POP4,P(25),T(25),MAXT,MINT,HMAX,HMIN,NSL,SAP
COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
DATA HSUN,HR SUN/1000.0,18.0/
DATA ITIM/0/
1  FORMAT(/, 2X,'DATE =',1X,I6,2X,'(MON)',4X,'NO OF RAOB LEVELS =',
1  13,4X,'SFC PRESS =',F7.1,4X,'SFC MAX TEMP =',14,4X,'SFC MIN TEMP
2  =',14,/)
2  FORMAT(/, 2X,'DATE =',1X,I6,2X,'(MON)',4X,'NO OF RAOB LEVELS =',
1  13,4X,'SFC PRESS =',F7.1,4X,'SFC MAX TEMP =',14,4X,'SFC MIN TEMP
2  =',14,/)
3  FORMAT(/, 2X,'DATE =',1X,I6,2X,'(TUE)',4X,'NO OF RAOB LEVELS =',
1  13,4X,'SFC PRESS =',F7.1,4X,'SFC MAX TEMP =',14,4X,'SFC MIN TEMP
2  =',14,/)
4  FORMAT(/, 2X,'DATE =',1X,I6,2X,'(WED)',4X,'NO OF RAOB LEVELS =',
1  13,4X,'SFC PRESS =',F7.1,4X,'SFC MAX TEMP =',14,4X,'SFC MIN TEMP
2  =',14,/)
5  FORMAT(/, 2X,'DATE =',1X,I6,2X,'(THU)',4X,'NO OF RAOB LEVELS =',
1  13,4X,'SFC PRESS =',F7.1,4X,'SFC MAX TEMP =',14,4X,'SFC MIN TEMP
2  =',14,/)
6  FORMAT(/, 2X,'DATE =',1X,I6,2X,'(FRI)',4X,'NO OF RAOB LEVELS =',
1  13,4X,'SFC PRESS =',F7.1,4X,'SFC MAX TEMP =',14,4X,'SFC MIN TEMP
2  =',14,/)
7  FORMAT(/, 2X,'DATE =',1X,I6,2X,'(SAT)',4X,'NO OF RAOB LEVELS =',
1  13,4X,'SFC PRESS =',F7.1,4X,'SFC MAX TEMP =',14,4X,'SFC MIN TEMP
2  =',14,/)
8  FORMAT(/, 2X,'DATE =',1X,I6,2X,'(SUN)',4X,'NO OF RAOB LEVELS =',
1  13,4X,'SFC PRESS =',F7.1,4X,'SFC MAX TEMP =',14,4X,'SFC MIN TEMP
2  =',14,/)
9  FORMAT(1H,63X,10A1,/)
   ITT=ITEMP(IT)
   IF (ITT.LT.MINT) ITT=MINT

C
C      IS IT DAYTIME (SAS GREATER THAN 0).
C      IF (SAS.GT.0.0) GO TO 100
C
C      IS IT SUNSET
C      IF (SAP.GT.0.0) GO TO 105
C      GO TO 120
C
C      LINEAR TEMPERATURE INTERPOLATION IS USED TO CALCULATE THE
C      DAYTIME MIXING DEPTH.
100 HT=HMIN+(ITT-MINT)*(HMAX-HMIN)/(MAXT-MINT)
   GO TO 132
105 HT=HMIN+(ITT-MINT)*(HMAX-HMIN)/(MAXT-MINT)
   HSUN=HT
   HRSUN=IT
C

```

```

C      AT SUNSET, PRINT THE BASIC STATION DATA, READ THE NEXT SOUNDING
C      AND CALCULATE THE MAX AND MIN MIXING DEPTHS, AND READ THE NEXT
C      DAYS FIRST FOUR HOURS OF SFC DATA.
108  IF (ICUT(1).LT.1) GO TO 115
      IF (ITIM.NF.1) PRINT 9,1STA
      IF (ICAHQ.EC.0) GO TO 110
      PRINT 1,IDATE,NSL,P(1),MAXT,MINT
      GO TO 115
110  GO TO(10,11,12,13,14,15,16),IDW
10   PRINT 2,IDATE1,NSL,P(1),MAXT,MINT
      GO TO 115
11   PRINT 3,ICATE1,NSL,P(1),MAXT,MINT
      GO TO 115
12   PRINT 4,ICATE1,NSL,P(1),MAXT,MINT
      GO TO 115
13   PRINT 5,IDATE1,NSL,P(1),MAXT,MINT
      GO TO 115
14   PRINT 6,IDATE1,NSL,P(1),MAXT,MINT
      GO TO 115
15   PRINT 7,ICATE1,NSL,P(1),MAXT,MINT
      GO TO 115
16   PRINT 8,ICATE1,NSL,P(1),MAXT,MINT
115  CALL RACBHM
      CALL SFCOR1
      ITIM=1
      GO TO 135

C
C      TIME INTERPOLATION IS USED TO CALCULATE THE MIXING DEPTH
C      AFTER SUNSET.
120  IF (IT.GT.15) GO TO 125
      GO TO 130
125  HT=HMIN+(HSLN-HMIN)*(24-IT)/(24-HRSUN)
      GO TO 132
130  HT=HMIN
132  IF (IABS(ITYP).EQ.3) GO TO 108
135  IF (HT.LT.50) HT=50.0
      SAP=SAS
      HS(IT)=HT
      RETURN
      END

```

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C      SUBROUTINE CALXQQ (HT,J1)
C
C      THIS SUBROUTINE CALCULATES THE X/Q VALUES FOR EACH OF THE
C      NINE SECTOR SEGMENTS USING THE GAUSSIAN AND BOX MODELS.
C
      DIMENSION      R(10),A(9,6),B(9,6),AA(54),BB(54)
      COMMON /QGF/ OL(10),QM(10),Q12(10),Q34(10),Q6(10),XQQ(10)
      COMMON /ALLC/ YS(351),IYN(351)
      1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2YRC,XC2,BY2,BY1,B12,B11,CRI,IY,IJ,XG,YG,SA,CA,NN,CR,LRL
      EQUIVALENCE (A,AA),(B,BB)
      DATA R      /1.0,125.0,250.0,500.0,1000.0,2000.0,4000.0,
      19000.0,16000.0,32000.0/
C
C      VALUES USED FOR THE STABILITY PARAMETERS (A AND B).
      DATA AA      /0.00,0.07,0.07,0.07,0.07,0.07,0.07,0.07,0.07,
      20.00,0.12,0.12,0.12,0.12,0.12,0.12,0.12,0.12,
      30.00,0.23,0.23,0.23,0.23,0.23,0.23,0.23,0.23,
      40.00,0.50,0.50,0.50,0.50,0.50,0.50,0.50,0.50,
      50.00,1.35,1.35,1.35,1.35,1.35,1.35,1.35,1.35,
      60.00,3.00,3.00,3.00,3.00,3.00,3.00,3.00,3.00/
      DATA BB      /0.00,1.28,1.28,1.28,1.28,1.28,1.28,1.28,1.28,
      20.00,1.14,1.14,1.14,1.14,1.14,1.14,1.14,1.14,
      30.00,0.97,0.97,0.97,0.97,0.97,0.97,0.97,0.97,
      40.00,0.77,0.77,0.77,0.77,0.77,0.77,0.77,0.77,
      50.00,0.51,0.51,0.51,0.51,0.51,0.51,0.51,0.51,
      60.00,0.31,0.31,0.31,0.31,0.31,0.31,0.31,0.31/
      HP2R=0.797885*HT
      DO 140 I=1,9
      UP2R=0.797885/AR(I)
      UH=HT*AR(I)
      IP1=I+1
      BIJ=B(I,J1)
      BIJ1=1.0-BIJ
      AIJ=A(I,J1)
      IF (I.GT.1) GO TO 25
      AIJ=A(2,J1)*R(2)**R(2,J1)
      GO TO 100
25  RT=(HP2R/AIJ)**(1.0/BIJ)
      IF (R(IP1)-RT) 100,100,115
100  IF (BIJ1) 110,105,110
105  XQQ(I)=(UP2R/AIJ)*ALOG(R(IP1)/R(I))
      GO TO 140
110  XCQ(I)=(UP2R/(AIJ*BIJ1))*(R(IP1)**BIJ1-R(I)**BIJ1)
      GO TO 140
115  IF (R(I)-RT) 125,125,120
120  XQQ(I)=(R(IP1)-R(I))/UH
      GO TO 140
125  IF (BIJ1) 135,130,135
130  XCQ(I)=(UP2R/AIJ)*ALOG(RT/R(I))+(R(IP1)-RT)/UH
      GO TO 140
135  XCQ(I)=(UP2R/(AIJ*BIJ1))*(RT**BIJ1-R(I)**BIJ1)+(R(IP1)-RT)/UH
140  CONTINUE
      RETURN
      END

```

```

      SUBROUTINE CALQUP (IWD,M)
C
C THIS SUBROUTINE COMPUTES THE CO EMISSION WITHIN EACH SECTOR SEGMENT.
C
      DIMENSION Y(20),X(20),IY(20),JY(20)
      COMMON/CITY/ ITYP,ISM,IOUT(10)
      COMMON/CPTS/ NPT,XPT(625),YPT(625)
      COMMON/CSTM/ VCAP(10),AST(10),WWST(10),ICST(10),NOC(10)
      COMMON /QUE/ Q1(10),Q2(10),Q3(10),Q4(10),Q5(10),XNQ(10)
      COMMON/CLCAT/ IFK(1200),X1(1200),X2(1200),Y1(1200),Y2(1200),F(1200)
      COMMON /ALLC/ YS(351),IYN(351)
      I,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2YRC,XC2,BY2,RV1,R12,B11,CPI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
      XG=XPT(M)
      YG=YPT(M)
      IF (IABS(ITYP).EQ.3) GO TO 205
      MCD=NOC(M)
205  ANG=ACR*IND
      CA=CCS(ANG)
      SA=SIN(ANG)
      Y12=0.0625*YRC
      DO 210 I=1,5
      Q12(I)=0.
      Q34(I)=0.
210  CONTINUE
      IF (ITYP.LT.0) GO TO 305
C
C BEGINNING OF LOOP FOR COMPUTING EMISSION WITHIN EACH SECTOR SEGMENT.
      DO 300 NC=1,NN
      IF (MCD.EQ.NC) GO TO 300
C
C TRANSFORMATION OF COORDINATES.
221  XD1=X1(NC)-XG
      YD1=Y1(NC)-YG
      XD2=X2(NC)-XG
      YD2=Y2(NC)-YG
      IYT=0
      YS1=XD1*SA+YD1*CA
      YS2=XD2*SA+YD2*CA
      IF (YS1.LT.YS2) GO TO 216
      YSS=YS1
      YS1=YS2
      YS2=YSS
      IYT=1
216  IF (YS2.IT.C.CR.YS1.GT.YC1) GO TO 300
      JY(1)=0
      JY(2)=0
      XS1=XD1*CA-YD1*SA
      XS2=XD2*CA-YD2*SA
      IF (IYT.EQ.0) GO TO 222
      XSS=XS1
      XS1=XS2
      XS2=XSS
C
C CHECK TO SEE IF LINK LIES WITHIN SECTOR.
222  B1=RY2
      B2=RY2
      IF (YS1.GT.YC2) GO TO 224

```

```

      B1=BY1
      IF (YS2.LT.YC2) B2=BY1
224  IF (ABS(XS1).LT.B1*YS1) GO TO 230
      IF (ABS(XS2).LT.B2*YS2) GO TO 232
      IF (XS1*XS2.LT.0) GO TO 234
      IF (YS1.GT.YC2.OR.YS2.LT.YC2) GO TO 300
      IF (ABS(XS1).LT.XC2.OR.ABS(XS2).LT.XC2) GO TO 234
      GO TO 300
231  IF (ABS(XS2).LT.B2*YS2) JY(2)=1
      JY(1)=1
      GO TO 234
232  JY(2)=1
234  X(1)=XS1
      X(2)=XS2
      Y(1)=YS1
      Y(2)=YS2
      YD=YS1-YS2+C.OOC1
      XD=XS1-XS2
      BL=XD/YD
      AL=XS1-BL*YS1
C
C   LOCATES THE SEGMENT WITHIN WHICH THE END POINTS OF THE LINK LIE.
      IF (YS1.GT.0) GO TO 236
      Y(1)=0.
      YS1=0.
      X(1)=AL
      XS1=AL
      IF (XS1.EQ.0.0) JY(1)=1
236  IY1=YS1*CR1+1
      IY2=YS2*CR1+1
      IF (IY2.GT.350) IY2=350
      IY(1)=IYN(IY1)
      IF (YS1.GE.YS(IY1)) IY(1)=IY(1)+1
      IY(2)=IYN(IY2)
      IF (YS2.GE.YS(IY2)) IY(2)=IY(2)+1
C
C   LOCATES THE INTERSECTIONS OF LINK WITH SECTOR DIVIDING LINES.
      N=2
      IF (IY(1).EQ.IY(2)) GO TO 250
      L=IY(1)
238  YP=YR(L)
      XP=AL+BL*YP
      IF (ABS(XP).GF.XP(L)) GO TO 240
      N=N+1
      X(N)=XP
      Y(N)=YP
      JY(N)=L
      IY(N)=L
      IF (L.EQ.LR4.AND.ABS(XP).GT.XRC) GO TO 240
      N=N+1
      X(N)=XP
      Y(N)=YP
      JY(N)=L+1
      IY(N)=L+1
240  L=L+1
      IF (L.LT.IY(2)) GO TO 238
C

```

C LOCATES THE INTERSECTIONS OF LINK WITH SIDES OF SECTOR.

```

250 K=1
260 IF (ABS(X(K)).LT.RY2*Y(K)) GO TO 280
    SR=1.0
    IF (X(K).LT.0) SR=-1.0
    B13=SB*B12
    XP=AL/(1.0-PL*B13)
    YP=B13*XP
    IF (YP.LT.YRC.OR.YP.GT.YC1) GO TO 270
    IYP=YP*CR+1
    N=N+1
    IY(N)=IYN(IYP)
    IF (IYP-Y5(IYP)) 266,262,264
262 IF (K.FQ.1) GO TO 264
    GC TO 266
264 IY(N)=IY(N)+1
265 X(N)=XP
    Y(N)=YP
    JY(N)=IY(N)
270 IF (ABS(X(K)).LT.RY1*Y(K)) GO TO 280
    B13=SB*B11
    XP=AL/(1.0-PL*B13)
    YP=B13*XP
    IF (YP.GT.YRC.OR.YP.LT.0) GO TO 280
    IYP=YP*CR+1
    N=N+1
    IY(N)=IYN(IYP)
    IF (IYP-Y5(IYP)) 276,272,274
272 IF (K.EC.1) GO TO 274
    GO TO 276
274 IY(N)=IY(N)+1
276 X(N)=XP
    Y(N)=YP
    JY(N)=IY(N)
280 K=K+1
    IF (K.LT.3) GO TO 260

```

C
C COMPUTES EMISSION CONTRIBUTION OF LINK TO EACH SEGMENT
C (RESULTS STORED IN Q).

```

DO 295 N1=1,N
    IF (JY(N1).EQ.0) GO TO 295
    NS1=IY(N1)
    IF (NS1.GT.LRL) GO TO 294
    NN1=N1+1
    DO 292 N2= NN1,N
        IF (JY(N2).EQ.0) GO TO 292
        NS2=IY(N2)
        IF (NS1.NE.NS2) GO TO 292
        YDN=X(N1)-X(N2)
        YDN=Y(N1)-Y(N2)
        QT=SQRT((XDN*XDN+YDN*YDN)*F(NC))
350 IF (IFX(NC).LT.3) GO TO 295
    GO TO 286
285 Q12(NS1)=Q12(NS1)+QT
    GO TO 290
286 Q34(NS1)=Q34(NS1)+QT
290 JY(N2)=0.0

```

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```
      GC TO 294
292 CONTINUE
294 JY(INI)=0
295 CONTINUE
C
C  END OF MAIN LOOP
300 CONTINUE
C
C  COMPUTES CO EMISSION WITHIN SEGMENTS FROM MINOR LINK DATA.
305 CALL CALLOC(M)
      RETURN
      END
```

SUBROUTINE CALLCC (N)

C
C
C
C

THIS SUBROUTINE USES THE GRID POINT VALUES (VCL AND VCM) TO
COMPUTE THE AVERAGE CO EMISSIONS WITHIN EACH SECTOR SEGMENT. THE
RESULTS ARE STORED IN QL AND QM.

C

```

REAL MRW,MCL
COMMON/CITY/ITY,ISM,IOUT(10)
COMMON/CPIS/ NPT,XPT(625),YPT(625)
COMMON /QLF/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),XNQ(10)
COMMON /CLOQ/ VCL(2500),VCM(2500),C9(3),SB(3),NRW,NCL,MRW,MCL,CLE,
IGSP,RGS,ZQX
COMMON/ALLC/ YS(351),IYN(351)
1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XPC,
2,YRC,XC2,RY2,RV1,BI2,BI1,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
XG=XPT(N)
YG=YPT(N)
DO 30 L=1,9
YRL=YR(L)
SEVL=C.0
SEVM=0.0
XDS=0.0
KTN=1
LD=1
IF (L.LT.5) GO TO 5
KTN=3
LD=L-3
5 WCT=0.25/LD
DO 20 J=1,LD
FXDS=1.0-WCT*(1.0+2.0*(LD-J))
YRR=YRL*FXDS
SSEVM=0.0
SSEVL=0.0
DO 10 K=1,KTN
DIVI=YRR/CR(K)
YM=(DIVI*(CA*CR(K)-SA*SB(K))+YG)*ZQX*MRW
XM=(DIVI*(SA*CH(K)+CA*SG(K))+XG)*ZQX*MCL
IYM=INT(YM)
IXM=INT(XM)
IF (IYM.LT.1.OR.IYM.GE.NRW) GO TO 10
IF (IXM.LT.1.OR.IXM.GE.NCL) GO TO 10
DYM=YM-IYM
DXM=XM-IXM
IXY=(IXM-1)*NRW+IYM
IYM1=1.0-DYM
DXM1=1.0-DXM
IXY1=IXY+1
TTFVL= (DYM1*VCL(IXY)+DYM*VCL(IXY1))*DXM1
1 +(CYM1*VCL(IXY+NRW)+DYM*VCL(IXY1+NRW))*DXM
SSEVL=SSEVL+TTFVL
IF(ITY.LT.0)GO TO 6
IF (L.LF.LRL) GO TO 10
6 TTFVM= (DYM1*VCM(IXY)+DYM*VCM(IXY1))*DXM1
1 +(CYM1*VCM(IXY+NRW)+DYM*VCM(IXY1+NRW))*DXM
SSEVM=SSEVM+TTFVM
10 CONTINUE
SEVL=SEVL+SSEVL*FXDS
SEVM=SEVM+SSEVM*FXDS

```

XDS=XDS+FXDS*KTN
20 CONTINUE
QL(L)=SEVL*AR(L)/XDS
IF(ITYP.LT.0)QL(L)=SEVM*AR(L)/XDS+QL(L)
IF(L.GT.LRL)QL(L)=SEVM*AR(L)/XDS+QL(L)
30 CONTINUE
RETURN
END

```

      SUBROUTINE LOCXCC(HT,J)
C
C THIS SUBROUTINE LOCATES THE PROPER X/Q VALUES FROM STORAGE.
C
      COMMON/CSAV/ J5,L7,I9,K36,HM1,SX70(320),SQ12(3240),SQ34(3240),
1          SCL(3240)
      COMMON /QLF/ GL(10),QM(10),Q12(10),Q34(10),QB(10),X70(10)
      HB=HM1+HM1+HM1
      DO 10 L=1,L7
      IF (HT,LT,HB) GO TO 12
10  HB=HB+HB
12  IF (L,GT,L7) L=L7
      LBS=(L-1)*19+(J-1)*L7+19
      DO 100 I=1,19
      IBS=I+LBS
100 XQ(I)=SX70(IBS)
      RETURN
      END

```

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```

      SUBROUTINE LOCQUE(KD,N)
C
C THIS SUBROUTINE LOCATES THE PROPER Q VALUES FROM STORAGE.
C
      COMMON/CSAV/ J5,L7,I9,K36,HM1,SX00(320),SQ12(3240),SQ34(3240),
1      SQL(3240)
      COMMON /QUE/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),X00(10)
      K=0.1*KD+0.5
      IF (K.LT.1) K=K36
      KBS=(K-1)*19+(N-1)*K36*19
      DO 100 I=1,19
      IBS=I+KBS
      Q12(I)=SQ12(IBS)
      Q34(I)=SQ34(IBS)
100  QL(I)=SQL(IBS)
      RETURN
      END

```

```

SUBROUTINE CALCCN (I,N,HT,EXTRAQ)
C
C      THIS SUBROUTINE COMPUTES THE CO CONCENTRATION AT THE
C      RECEPTOR POINT BASED ON THE VARIOUS MODELS. THE DIURNAL TRAFFIC
C      PATTERNS FOR WEEKDAYS, SATURDAYS, SUNDAYS, AND HOLIDAYS ARE INCLUDED
C      IN THE CO CALCULATIONS.
C
COMMON/CITY/ ITYP,ISM,IOUT(10)
COMMON/CPIS/ NPT,XPT(625),YPT(625)
COMMON /DAY/ IDW,NH,IDAHO,IHW,IDWT
COMMON/MIX/ISTA(10),IYP,IMD,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,
X IDATE9
COMMON /PNT/ IC,PT2,IJS(24),HS(24),HR(168),CCAL(1200)
COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
COMMON /CAR/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
COMMON /QUE/ QL(10),QM(10),Q12(10),Q34(10),Q6(10),XQ(10)
COMMON /ALLC/ YS(351),IYN(351)
1,XR(10),YR(10),AR(10),EFAC(9),ACR,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
2,YRC,XC2,BY2,RY1,BI2,BI1,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
COMMON/CN24/ N24
IT=1
3 IF (N.EQ.1) IC=IC+1
10 CPL=0.0
WSI75=0.75/(223.6932*WS(IT))
IDWT=IDW
IF (IDAHO.EQ.0) GO TO 15
IDWT=7
15 DO 120 J=1,C
ITT = IT-IFIX(YR(J)*WSI75)+IDS
IF (ITT.LT.1) ITT=ITT+24
IF (ITT.GT.24) ITT=1
IF (ICWT-6)100,105,110
4 IF (ICWT-6)100,105,110
C
C      WEEKDAY CONCENTRATION CALCULATIONS.
103 IF (ITYP.LT.0) GO TO 104
FACT = Q12(J)*PT12(ITT)+Q34(J) +QL(J)*PT34(ITT)
GO TO 120
104 FACT=QL(J)*PT12(ITT)+QL(J)*PT34(ITT)
GO TO 120
C
C      SATURDAY CONCENTRATION CALCULATIONS.
105 FACT = PTSAT(ITT)*Q12(J)+Q34(J) +QL(J)
GO TO 120
C
C      SUNDAY AND HOLIDAY CONCENTRATION CALCULATIONS.
117 FACT = PTSUN(ITT)*Q12(J)+Q34(J) +QL(J)
120 CPL=CPL+FACT*XQ(J)
CPL=CPL/WS(IT)
IU=N
IF (IARS(ITYP),LT.3) IO=IT+(N-1)*N24
CCAL(ID)=(CPL+EXTRAQ)*1000.0
137 RETURN
END

```

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```

12=72C
14=240
30 13=12+240
    15=14+240
    CCAL(ID+12)=DBAS*XL1+CBG
    CCAL(ID+13)=DBAS*XL2+CBG
    CCAL(ID+14)=DBAS*W1*HZ1+CBG
    CCAL(ID+15)=DBAS*W1*HZ2+CBG
50 1TIME=1
    RETURN
    END

```

```

      SUBROUTINE STREET(I,N)
C
C THIS SUBROUTINE COMPUTES THE STREET PROFILE OF CO CONCENTRATIONS BASED
C ON THE BACKGROUND VALUES, THE STREET EMISSION VALUES, AND THE
C METEOROLOGICAL CONDITIONS (RESULTS ARE STORED IN ARRAY CCAL).
C
      COMMON/CSM/ VCAR(10),AST(10),WAST(10),ICST(10),NOCD(10)
      COMMON /DAY/ IDW,NH,IDAHO,IHW,IDWT
      COMMON/PIX/ISTA(10),IYP,IWD,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,
      X IDATE2
      COMMON /SEC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITMP(24)
      COMMON /CAP/ PT12(24),PT34(24),PT6(24),PTSAT(24),PTSUN(24)
      COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
      COMMON /ALLC/ YS(351),IYN(351)
      I,XP(10),YP(10),AP(10),FFAC(9),ACK,LR4,LR5,LR9,LR10,AG,YC1,YC2,XRC,
      2YRC,YC3,AY2,AY1,B12,B11,CRI,IT,IJ,XG,YG,SA,CA,NN,CR,LRL
      COMMON/CN24/ N24
      DATA Z3,Z1,Z2,X,ZLD,CK,ITIME/38.8,3.65,27.8,8.,2.,7.,0/
      IF (ITIME.EQ.1) GO TO 10
      DAN=0.87*CK/1.609
      X2=X*X
      XL1=1.0/(SQRT(Z1*Z1+X2)+XL0)
      XL2=1.0/(SQRT(Z2*Z2+X2)+XL0)
      HZ1=(Z3-Z1)/Z3
      HZ2=(Z3-Z2)/Z3
10  ID=1+(N-1)*N/24
      CRG=CCAL(ID)
      W=WAST(N)
      ICS=ICST(N)
      DCH=DAN*FFAC(ICS)
      DCH5=0.5*DCH
      WI=1.0/W
      ITT=1+IDS
      IF (ITT.GT.24) ITT=1
      IF (IDWT.EQ.12,14,16)
12  PT9=PT16(ITT)
      GO TO 13
14  PT9=PTSAT(ITT)
      GO TO 13
16  PT9=PTSUN(ITT)
18  CR5=VCAR(N)*PT9/(0.5*WS(I)+0.25)
      AWD=IWD(I)
      IF (AWD.LT.AST(N)) AWD=AWD+360.0
      ANG=AWD-AST(N)
      IF (ANG.GT.180.0) ANG=ANG-360.0
      AANG=ABS(ANG)
      IF (AANG.GT.90.0) AANG=180.0-AANG
      IF (AANG.GT.30.0) GO TO 25
      CRAS=DCH5*CR5
      CCAL(I0+240)=CRAS*(XL1+WI)+CRG
      CCAL(I0+720)=CRAS*(XL1+WI)+CRG
      CCAL(I0+480)=CRAS*(XL2+WI)+CHG
      CCAL(I0+960)=CRAS*(XL2+WI)+CHG
      GO TO 50
25  CRAS=DCH*CR5
      I2=240
      I4=720
      IF (ANG.LT.0.0) GO TO 30

```

```

SUBROUTINE PPDATA
C
C THIS SUBROUTINE PRINTS AND PUNCHES OUT THE STATION ID, DATE, MAX-MIN
C TEMPERATURES, ALL SFC DATA, STABILITY INDEX, MIXING DEPTH, AND THE
C CALCULATED CO CONCENTRATIONS.
C
COMMON/CITY/ ITYP,ISM,IOUT(10)
COMMON/CPTS/ NPT,XPT(625),YPT(625)
COMMON /DAY/ IDW,NH,ICAH,IMH,IDWT
COMMON/MIX/ISTA(10),IYR,IMD,IDA,DAY,IDS,IHD,IST,IDATE,IDATE1,
X IDATE9
COMMON /PNT/ IC,RT2,IJS(24),HS(24),HR(168),CCAL(1200)
COMMON /SFC/ IHR(24),ICHT(24),IWD(24),WS(24),ICLD(24),ITEMP(24)
COMMON/CN24/ N24
DATA ITIM/0/
1  FORMAT(2X,'HOUR CLD-C TEMP WND-D WND-S STB-I MIX-D CO-RG
X CO-R1 CO-R2 CO-L1 CO-L2')
2  FORMAT(2X,'HOUR CLD-C TEMP WND-D WND-S STB-I MIX-D',
X ' CO-RG')
3  FORMAT(2X,I4,I7,I5,I7,F7.1,I7,F8.1,5F7.2)
4  FORMAT(2X,I4,I7,I5,I7,F7.1,I7,F8.1,F7.2)
5  FORMAT(6X,' STA',I4)
6  FORMAT (A10,I10,4I4,F4.0,I4,F5.0,5F6.2)
7  FORMAT(A10,I10,3I4,F4.0,I4,F5.0)
8  FORMAT(' CITY DATE HR PT CLD DIR SPD SI MD CRG
ICR1 CR2 CL1 CL2')
9  FORMAT(' CITY DATE HR CLD DIR SPD SI MD')
10  FORMAT(I4,F6.2)
11  IF(IOUT(1).LT.1)GO TO 100
12  DO 20 I=1,NPT
ICR=(I-1)*N24
PRINT 9,I
IF(IABS(ITYP).EQ.3)GO TO 6
IF(ISM.EQ.0)GO TO 6
PRINT 1
DO 5 J=1,24
PRINT 3,J,ICLD(J),ITEMP(J),IWD(J),WS(J),IJS(J),HS(J),CCAL(ICR+J),
X CCAL(ICR+(240+J)),CCAL(ICR+(480+J)),CCAL(ICR+(720+J)),
X CCAL(ICR+(960+J))
GO TO 20
6  PRINT 2
IF(IABS(ITYP).EQ.3)GO TO 8
DO 7 J=1,24
PRINT 4,J,ICLD(J),ITEMP(J),IWD(J),IWD(J),WS(J),IJS(J),HS(J),
X CCAL(ICR+J)
GO TO 20
8  ICA=ICR+1
PRINT 4,IMD,ICLD(IMD),ITEMP(IMD),IWD(IMD),WS(IMD),IJS(IMD),
X HS(IMD),CCAL(ICA)
20  CONTINUE
C
C PUNCH OUT OUTPUT DATA IF IOUT(2) GT ZERO.
100 IF (IOUT(2).LT.1) GO TO 200
IF(IABS(ITYP).GT.2)GO TO 150
IF(ITIM.NE.1)PUNCH 12
DO 105 I=1,24
DO 105 N=1,NPT
ICR=(N-1)*N24+I

```

```

105 PUNCH 10, ISTA, ICATF, I, N, ICLD(1), IWD(2), WS(1), IJS(1), HS(1),
1 CCAL(ICB), CCAL(ICB+240), CCAL(ICB+480), CCAL(ICB+720), CCAL(ICB+960)
GO TO 200
150 I=IWD
IF (ITIM.NE.1) PUNCH 13
PUNCH 11, ISTA, ICATF, I, ICLD(1), IWD(1), WS(1), IJS(1), HS(1)
PUNCH 14, (N, CCAL(N), N=1, NPT)
200 IF (ICUT(3).LT.1) GO TO 300
IF (IARS(ITYP).GT.2) GO TO 250
DO 205 I=1, 24
DO 205 N=1, NPT
ICR=(N-1)*N24+I
205 WRITE (41)
1 ISTA, IDATE, I, N, ICLD(1), IWD(1), WS(1), IJS(1), HS(1),
2 CCAL(ICB), CCAL(ICB+240), CCAL(ICB+480), CCAL(ICB+720), CCAL(ICB+960)
GO TO 300
250 I=IWD
WRITE (41)
1 ISTA, ICATF, I, ICLD(1), IWD(1), WS(1), IJS(1), HS(1)
2 (N, CCAL(N), N=1, NPT)
300 IHW=IHW+24
ITIM=1
IDATE=ICATF1
RETURN
END

```

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Appendix C

EXAMPLE OF INPUT DATA

BASIC INPUT INFORMATION--CARDS A THROUGH M
(Data Read-in by Subroutine INDAT)

								Card*
1997.0	1	2071.0	1	197.0	2	14692.0	1	A
2001.0		2073.0		287.0		0088.0		B 1
38.6		2.36		1931.5		2040.5		B 2
11.02		15.56		15.17		12.20		C
4.10		6.19		4.78		4.78		D(1)
43.0		9.0		53.0		20.0		D 2
	2		2		2		2	E
	1		2		2		2	F(1)
	1		1		1		2	F 2
0.0121		0.0080		0.0046		0.0042		F 3
0.0659		0.0606		0.0634		0.0628		G 1
0.0796		0.0554		0.0354		0.0280		G 2
0.017		0.010		0.006		0.005		G 3
0.050		0.045		0.046		0.044		H(1)
0.076		0.061		0.053		0.052		H 2
0.0121		0.0080		0.0046		0.0042		H 3
0.0659		0.0606		0.0634		0.0628		I(1)
0.0796		0.0554		0.0354		0.0280		I 2
0.015		0.010		0.007		0.008		I 3
0.053		0.062		0.064		0.068		J 1
0.062		0.059		0.051		0.042		J 2
0.014		0.008		0.006		0.005		J 3
0.028		0.036		0.036		0.041		K 1
0.056		0.052		0.042		0.034		K 2
710826		710827		4		8		K 3
710906							1	L
								M 1

* See Tables 2, 3, and 4.

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TRAFFIC INPUT DATA--CARDS N AND Ø *
(Data Read-in by Subroutine LINKS)

										Card
1016	1017	1998	2074	1996	2068	14692	2	6		N(1)
1006	1016	2004	2072	1998	2074	6088	2	7		N(2)
1000	1001	1981	2004	1996	2043	13333	2	43		N(3)
1001	1002	1996	2043	1998	2049	15600	2	6		
1002	1003	1998	2049	2000	2055	16400	2	6		
1003	1004	2000	2055	2001	2061	16400	2	5		
1004	1005	2001	2061	2003	2066	16400	2	6		
1005	1006	2003	2066	2004	2072	14000	2	6		
1006	1007	2004	2072	2007	2083	11600	2	11		
1007	1008	2007	2083	2010	2098	11600	2	10		
1073	1022	1932	2018	1966	2008	24095	4	30		
1000	1021	1931	2004	1990	2045	22500	2	43		
1001	1021	1996	2043	1990	2045	8000	2	7		
1002	1020	1998	2049	1991	2051	15500	2	6		
1003	1019	2000	2055	1993	2057	7000	2	7		
1004	1018	2001	2061	1995	2063	8000	2	7		
1005	1017	2003	2066	1996	2068	6500	2	7		
1007	1015	2007	2083	2001	2084	13000	2	7		
1008	1014	2010	2098	2003	2095	20000	2	6		
1008	1009	2010	2098	2014	2098	17500	2	7		
1009	1011	2014	2098	2044	2094	11100	2	29		
1007	1010	2007	2083	2041	2080	8400	2	33		
1009	1013	2014	2098	2005	2103	16000	2	11		
1009	1012	2014	2098	2010	2110	86480	2	15		
1012	1013	2010	2110	2005	2103	15000	2	10		
1013	1014	2005	2103	2003	2095	16250	2	9		
1013	1032	2005	2103	1998	2105	16500	2	7		
1014	1015	2003	2095	2001	2084	17500	2	11		
1014	1031	2003	2095	1997	2096	20000	2	7		
1015	1016	2001	2084	1998	2074	17500	2	11		
1015	1030	2001	2084	1994	2086	13000	2	7		
1016	1029	1998	2074	1991	2076	6000	2	7		
1017	1018	1996	2068	1995	2063	20000	2	6		
1017	1028	1996	2068	1990	2070	6500	2	7		
1018	1019	1995	2063	1993	2057	20000	2	6		
1018	1027	1995	2063	1989	2065	8000	2	7		
1019	1020	1993	2057	1991	2051	22500	2	7		
1019	1026	1993	2057	1988	2059	7000	2	7		
1020	1021	1991	2051	1990	2045	22500	2	7		
1020	1025	1991	2051	1979	2055	15500	2	13		
1021	1024	1990	2045	1978	2049	8000	2	13		
1024	1023	1978	2049	1970	2040	8000	2	11		
1024	1025	1978	2049	1979	2055	8000	2	6		
1023	1022	1970	2040	1966	2008	9000	2	34		
1025	1041	1979	2055	1973	2056	15500	2	6		
1025	1040	1979	2055	1981	2061	8000	2	7		
1040	1026	1981	2061	1988	2059	7000	2	6		
1040	1042	1981	2061	1975	2063	7000	2	6		
1026	1027	1983	2059	1939	2065	4500	2	6		
1027	1028	1989	2065	1990	2070	4500	2	6		
1027	1039	1989	2065	1982	2066	8000	2	6		
1028	1029	1990	2070	1991	2076	4500	2	6		
1028	1038	1990	2070	1984	2072	6500	2	6		
1029	1030	1991	2076	1994	2086	4500	2	10		
1029	1037	1991	2076	1986	2077	6000	2	6		
1030	1031	1994	2086	1997	2096	6500	2	11		N(56)
1030	1036	1994	2086	1989	2087	15000	2	6		N(57)

* The link data (type N cards) given in this example represents only a fraction of the total link data for St. Louis.

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TRAFFIC INPUT DATA--CARDS N AND ϕ (Continued)

										Card
1031	1032	1997	2096	1998	2105	8500	2	9		N(58)
1031	1035	1997	2096	1991	2098	17000	2	6		N(59)
1032	1033	1998	2105	1997	2113	8500	2	10		N(60)
1032	1034	1998	2105	1992	2106	16500	2	6		
1034	1033	1992	2106	1997	2113	8500	2	10		
1034	1048	1992	2106	1981	2109	17000	2	12		
1034	1035	1992	2106	1991	2098	7500	2	9		
1035	1036	1991	2098	1989	2087	7500	2	11		
1035	1047	1991	2098	1985	2099	17000	2	6		
1036	1037	1989	2087	1986	2077	7500	2	10		
1036	1046	1989	2087	1982	2088	13000	2	6		
1037	1038	1986	2077	1984	2072	7500	2	6		
1037	1045	1986	2077	1980	2079	6000	2	6		
1038	1039	1984	2072	1982	2066	6500	2	6		
1038	1044	1984	2072	1978	2074	7250	2	6		
1039	1040	1982	2066	1981	2061	6500	2	6		
1039	1043	1982	2066	1977	2068	6500	2	6		
1041	1055	1973	2056	1967	2058	15500	2	6		
1041	1042	1973	2056	1975	2063	6000	2	6		
1042	1043	1975	2063	1977	2068	6000	2	6		
1042	1040	1975	2063	1981	2061	7000	2	6		
1042	1054	1975	2063	1969	2064	7000	2	6		
1043	1044	1977	2068	1978	2074	6000	2	6		
1043	1053	1977	2068	1970	2070	8000	2	6		
1044	1045	1978	2074	1980	2079	6000	2	6		
1044	1052	1978	2074	1972	2075	8000	2	6		
1045	1046	1980	2079	1982	2088	6000	2	10		
1045	1051	1980	2079	1974	2081	6000	2	6		
1046	1047	1982	2088	1985	2099	6000	2	11		
1046	1050	1982	2088	1976	2090	15500	2	6		
1047	1049	1985	2099	1979	2101	17000	2	6		
1049	1048	1979	2101	1981	2109	9000	2	8		
1049	1062	1979	2101	1973	2102	17000	2	6		
1049	1050	1979	2101	1976	2090	9000	2	11		
1048	1094	1981	2109	1979	2117	9000	2	10		
1048	1063	1981	2109	1974	2110	18500	2	6		
1094	1063	1979	2117	1974	2110	9000	2	10		
1050	1051	1976	2090	1974	2081	5500	2	9		
1050	1061	1976	2090	1970	2091	16000	2	6		
1051	1060	1974	2081	1968	2083	16000	2	6		
1051	1052	1974	2081	1972	2075	5500	2	6		
1052	1059	1972	2075	1966	2077	8000	2	6		
1052	1053	1972	2075	1970	2070	5500	2	6		
1053	1058	1970	2070	1964	2072	8000	2	6		
1053	1054	1970	2070	1969	2064	5500	2	6		
1054	1057	1969	2064	1963	2066	7000	2	6		
1054	1055	1969	2064	1967	2058	5500	2	6		
1055	1056	1967	2058	1961	2060	20000	2	6		
1056	1057	1961	2060	1963	2066	6500	2	6		
1056	1071	1961	2060	1947	2064	25000	2	15		
1057	1058	1963	2066	1964	2072	6500	2	6		
1057	1070	1963	2066	1948	2069	8750	2	15		
1058	1059	1964	2072	1966	2077	6500	2	6		
1058	1069	1964	2072	1950	2075	8000	2	15		
1059	1060	1966	2077	1968	2083	6500	2	6		N(112)
1059	1068	1966	2077	1951	2080	8000	2	16		N(113)

TRAFFIC INPUT DATA--CARDS N AND Ø (Continued)

1060	1061	1968	2083	1970	2091	6500	2	9	Card
1060	1067	1968	2083	1952	2086	6000	2	15	N(114)
1061	1062	1970	2091	1973	2102	6000	2	11	N(115)
1061	1066	1970	2091	1955	2095	16000	2	15	N(116)
1062	1063	1973	2102	1974	2110	6000	2	8	
1062	1065	1973	2102	1957	2106	0	2	15	
1063	1064	1974	2110	1959	2114	20500	2	15	
1064	1065	1959	2114	1957	2106	21500	2	9	
1064	1083	1959	2114	1948	2117	13000	2	12	
1065	1066	1957	2106	1955	2095	21500	2	11	
1065	1082	1957	2106	1945	2109	14500	2	12	
1066	1067	1955	2095	1952	2086	25000	2	10	
1066	1081	1955	2095	1939	2099	14000	2	16	
1067	1068	1952	2086	1951	2080	29000	2	6	
1067	1080	1952	2086	1937	2091	6000	2	17	
1068	1079	1951	2080	1935	2084	8500	2	15	
1068	1069	1951	2080	1950	2075	29000	2	6	
1069	1078	1950	2075	1934	2079	8000	2	15	
1069	1070	1950	2075	1948	2069	29000	2	6	
1070	1077	1948	2069	1933	2073	10500	2	15	
1070	1071	1948	2069	1947	2064	28000	2	5	
1071	1076	1947	2064	1932	2069	28500	2	15	
1075	1074	1928	2052	1919	2021	9000	2	32	
1075	1076	1928	2052	1932	2069	9500	2	16	
1075	1092	1928	2052	1900	2059	8000	2	29	
1076	1077	1932	2069	1933	2073	9500	2	5	
1076	1091	1932	2069	1902	2076	37000	2	30	
1077	1090	1933	2073	1903	2080	7000	2	30	
1077	1078	1933	2073	1934	2079	10750	2	6	
1078	1089	1934	2079	1905	2085	6500	2	30	
1078	1079	1934	2079	1935	2084	11000	2	5	
1079	1088	1935	2084	1906	2091	18000	2	30	
1079	1080	1935	2084	1937	2091	12000	2	8	
1080	1081	1937	2091	1939	2099	12000	2	8	
1081	1086	1939	2099	1909	2106	14500	2	30	
1081	1082	1939	2099	1945	2109	14000	2	8	
1082	1083	1945	2109	1948	2117	14000	2	9	
1082	1085	1945	2109	1914	2117	10000	2	31	
1083	1084	1948	2117	1916	2125	9000	2	31	
1086	1087	1909	2106	1908	2097	6000	2	8	
1080	1087	1937	2091	1908	2097	7000	2	30	
1087	1088	1908	2097	1906	2091	6000	2	7	
1088	1069	1906	2091	1905	2085	6000	2	6	
1089	1090	1905	2085	1903	2080	7000	2	6	
1090	1091	1903	2080	1902	2076	9000	2	5	
1091	1092	1902	2076	1900	2059	13000	2	15	
1092	1093	1900	2059	1892	2028	11500	2	31	
1083	1095	1948	2117	1956	2125	21500	2	14	
1085	1096	1914	2117	1912	2121	10000	2	6	
1084	1096	1916	2125	1912	2121	10000	2	6	
1087	1097	1908	2097	1908	2110	6000	2	4	
1086	1097	1909	2106	1908	2110	6000	2	5	N(165)
1309	1354	1600	1805	1555	1810	26150	4	55	N(166)
9									Terminator
		900		1300			2		Ø(1)
		1300		2300			7		Ø(2)

TRAFFIC INPUT DATA--CARDS N AND ϕ (Continued)

			Card
1300	3300	5	$\phi(3)$
1100	1300	3	$\phi(4)$
1500	2300	8	$\phi(5)$
1900	3100	3	
900	1500	2	
1700	2300	9	
1900	2900	3	
1100	1500	3	
900	2500	5	
1900	2500	2	
1300	1500	6	
1100	2500	3	
1900	2300	8	
1500	1500	8	
1300	2500	1	
1900	2100	4	
700	1700	2	
1500	2500	8	
1900	1900	6	
900	1700	6	
1700	2500	3	
1900	1700	1	
1100	1700	8	
500	2700	1	
1900	700	1	
1300	1700	2	
700	2700	1	
2100	2700	2	
1500	1700	8	
900	2700	4	
2100	2500	1	
1700	1500	2	
1100	2700	4	
2100	2300	1	
1700	1700	7	
1300	2700	4	
2100	2100	3	
700	1900	2	
1500	2700	4	
2100	1900	1	
900	1900	5	
1700	2700	5	
2100	1700	3	
1100	1900	7	
700	2900	1	
2300	2900	1	
1300	1900	8	
900	2900	1	
2300	2300	1	
1500	1900	9	
1100	2900	1	
2300	2100	8	
1700	1900	8	
1300	2900	8	
2300	1900	2	$\phi(57)$
700	2100	2	$\phi(58)$

TRAFFIC INPUT DATA--CARDS N AND Ø (Concluded)

			<u>Card</u>
1500	2900	7	Ø(59)
2300	1700	3	Ø(60)
900	2100	1	Ø(61)
1700	2900	5	
2500	2300	6	
1100	2100	6	
700	3100	1	
2500	2100	8	
1300	2100	7	
900	3100	1	
2500	1900	7	
1500	2100	2	
1100	3100	3	
2500	1700	2	
1700	2100	4	
1300	3100	7	
2700	2100	1	
500	2300	1	
1500	3100	2	
2900	1300	7	
700	2300	3	
1700	3100	2	
2700	1500	1	
900	2300	3	
900	3300	1	
2900	2300	4	
1100	2300	7	
1100	3300	6	Ø(86)
2900	1500	4	Ø(87)
			Terminator

9

METEOROLOGICAL INPUT DATA--CARDS P, Q, AND R
(Data Read-in by Subroutines RASBHM, SPCB61 and SPCB62)

ST LOUIS	710826	34	58	1	Card
03879710826120102 -	0158095001740	09930	230302	P	
03879710826120203 -	0183094002090	09890	251002	Q(1)	
03879710826120304 -	0215048002790	09810	264003	Q(2)	
03879710826120405 -	0226032003140	09770	267003	Q(3)	
03879710826120506 -	0219029005940	09460	295005		
03879710826120607 -	0154031015110	08500	301007		
03879710826120708 -	0097031022000	07830	310011		
03879710826120809 -	0076005027900	07290	290014		
03879710826120910 -	0055010031230	07000	290017		
03879710826121011 -	0020004039780	06300	292017	Q(10)	
03879710826121112 -	-095003058020	05000	302017	Q(11)	
710826 0 0 68 63 00 00				R(1)	
710826 1 0 66 62 27 04				R(2)	
710826 2 0 66 59 26 04				R(3)	
710826 3 0 65 60 33 10					
710826 4 0 64 58 27 04					
710826 5 0 61 58 27 04					
710826 6 0 61 58 27 04					
710826 7 0 65 60 30 05					
710826 8 0 68 60 33 10					
710826 9 0 72 59 36 05					
710826 10 0 76 59 32 05					
710826 11 0 79 59 34 05					
710826 12 0 81 58 30 10					
710826 13 1 82 59 30 13					
710826 14 1 83 56 34 14					
710826 15 1 84 54 32 14					
710826 16 1 82 55 32 09					
710826 17 0 80 56 35 11					
710826 18 0 76 57 34 13					
710826 19 0 71 56 36 10					
710826 20 0 68 56 01 09					
710826 21 0 64 56 32 08					
710826 22 0 61 56 01 07					
710826 23 0 60 56 36 07				R(23)	
ST LOUIS 710827 76 53				R(24)	
03879710827120102 -	0119097001740	09965	350002	P	
03879710827120203 -	0144096003230	09790	011004	Q(1)	
03879710827120304 -	0132073007750	09280	012005	Q(2)	
03879710827120405 -	0106084011920	08830	347006		
03879710827120506 -	0104054015100	08500	331007		
03879710827120607 -	0113030017190	08290	327007		
03879710827120708 -	0068020026370	07420	316010		
03879710827120809 -	0075006027940	07280	313009		
03879710827120910 -	0061009031160	07000	319008		
03879710827121011 -	0050009036210	06580	329014		
03879710827121112 -	0025008041820	06140	328019		
03879710827121213 -	-037009049890	05550	332018	Q(12)	
03879710827121314 -	-078006058060	05000	335020	Q(13)	
710827 0 0 58 55 03 04				R(1)	
710827 1 0 58 56 01 06					
710827 2 0 58 56 35 07					
710827 3 0 57 56 33 04					
710827 4 0 55 55 00 00					
710827 5 0 54 54 27 04					
710827 6 0 53 53 30 05				R(7)	

METEOROLOGICAL INPUT DATA--CARDS P, Q, AND R (Concluded)

710827	7	0	57	57	28	04		Card
710827	8	0	62	58	35	06		R(8)
710827	9	1	67	57	35	06		
710827	10	7	70	56	36	10		
710827	11	8	71	56	35	07		
710827	12	8	73	55	36	07		
710827	13	6	73	54	01	08		
710827	14	6	75	55	34	09		
710827	15	3	76	55	01	08		
710827	16	2	75	54	34	10		
710827	17	3	74	54	36	11		
710827	18	2	72	54	36	08		
710827	19	0	67	55	01	05		
710827	20	0	65	56	35	03		
710827	21	0	64	56	35	03		
710827	22	0	63	56	00	00		
710827	23	0	61	57	00	00		R(24)
ST LOUIS	710828	84	55					P
03879710828120102	-	0127094001740	09986	030002				Q(1)
03879710828120203	-	0169081002730	09870	031002				
03879710828120304	-	0169073003780	09750	031003				
03879710828120405	-	0112077012350	08810	011006				
03879710828120506	-	0103064015340	08500	002006				
03879710828120607	-	0110332017530	08280	010005				
03879710828120708	-	0085021024100	07650	001007				
03879710828120809	-	0088004028990	07210	358007				
03879710828120910	-	0076004031430	07000	359007				
03879710828121011	-	0079002034060	06780	358008				
03879710828121112	-	0006003047730	05730	352010				
03879710828121213	-	0081005058490	05000	332011				Q(12)
710828	0	0	60	58	27	04		R(1)

Appendix D

EXAMPLE OF OUTPUT DATA

ST LOUIS

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